RADIO *and* ELECTRONICS

TELEVISION - COMMUNICATIONS - SERVICE - SOUND

JANUARY 1st, 1954

VOL. 8, NO. 11

Radio and Electronics

Our cover picture this month shows the main transmitter hall at Himatangi Radio. In the middle distance is the Control Console from which all transmitters can be operated. The transmitter on the left is the single-sideband R/T transmitter used on the direct circuit to London for radio-telephone conversations.

Official Journal of

The N.Z. Electronics Institute (Inc.).

The N.Z. Radio and Television Manufacturers' Federation.

The N.Z. Radio and Electrical Traders' Federation.

N.Z. Radio, TV and Electrical Assn. (Inc.).

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Subscriptions:
1s. 10d. per copy; 23s. 6d. per annum, posted.

Advertising Rates supplied on application.

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Telegrams and Cables:
"Radel," Wellington.

SOLE ADVERTISING REPRESENTATIVES for THE UNITED KINGDOM:
Cowlishaw and Lawrence (Advertising), Ltd., 28 New Bridge Street, London, E.C.4.
Telephone City 5118.
Cables: Cowlawads Cent, London.

VOL. 8, No. 11 — 1st January, 1954

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Sole New Zealand Distributors: Gordon & Gotch (N.Z.) Ltd., Wellington

PRINTED BY HARRY H. TOMBS, LTD., WINGFIELD STREET, WELLINGTON.

TV in Retrospect and Prospect

In one way, the year 1953 has been a disappointing one for the radio industry. The high hopes which everyone had entertained of some progress at least towards the establishment of television in New Zealand were rudely dashed to the ground late in September, when the Government announced that not only was it not prepared to set up a television service itself, but also that it would not consider any possibility other than a State-owned and operated venture into this field.

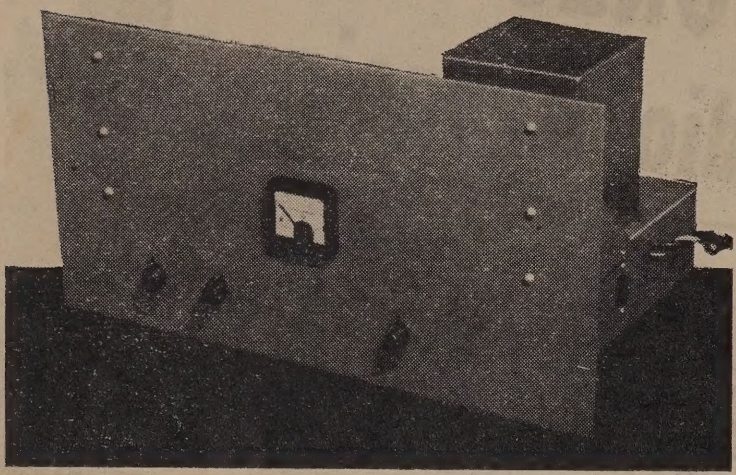
To those who had hoped for better things, this announcement was somewhat of a blow, not so much because it said, "No television now," but because, in effect, it proclaimed, "No television for an indefinite period." No one can reasonably blame the Government for not wishing to spend large sums of money on television, at a time when sterling is still controlled (by the same Government) and when so much remains to be done with the taxpayers' money in other, more urgent, directions. What the Government can legitimately be blamed for, however, is that it has spent so much time in committees of one sort and another, up to and including a special sub-committee of Cabinet, without coming to any decisions whatever, other than this one.

The statement made by the Minister of Broadcasting was really an extraordinary document. On the one hand, he said that we would be well advised to wait, if only because technical developments were taking place at so rapid a rate. The implication of this was, of course, that if we did anything about instituting TV now, we might later turn out to be at a technical disadvantage through not having waited. Then, in the next breath, he announced that the recommendation was that when TV started here we should adopt the British system of technical standards. These two statements are implicitly contradictory, and the trouble is that it takes a technically trained man to spot the contradiction. We were thus treated to the somewhat ridiculous spectacle of at least one newspaper editor solemnly agreeing with both of them. In fact, of course, recommending British standards is tantamount to saying that future technical developments are very unlikely to cause embarrassment to any TV service, existing or projected. If the Minister believes this, then his recommendation for waiting, on technical grounds, is nonsense. Similarly, if we really should wait upon pending developments, he has no business to recommend a standard which, of the four in current use, is the most likely to become out-moded. He really cannot have it both ways.

Then, as if this were not enough for one official statement, the Minister sought to add "artistic verisimilitude to an otherwise bald and unconvincing narrative" by going to such futile lengths as to quote Wellington's hills as one of the "difficulties" confronting the establishment of TV in this country. Does he consider that, by waiting for an unspecified number of years before whispering the word "television" again, we will find that these hills, and the difficulties associated with them, will have disappeared? He admitted that TV would have to come sooner or later, and that its advent could not indefinitely be put off. And then to put it off indefinitely was just what he did! The Government might just as well have come out in the open and said, "We don't like the look of this thing politically, so we're leaving it for some other party to burn its fingers with."

So much for retrospect. What, then, are the prospects? Only the most incurable optimist would say that they are rosy. This is being written early in December, but if we are permitted to hazard a guess we would say that the demonstrations at the Industrial Fair in Wellington will create a good deal of public interest. Those with a little imagination will certainly ask themselves whether television could not have made the Royal tour a much more exciting and memorable occasion for many of those who were unable to stand in crowded streets to see Her Majesty pass. What would old people, and those in hospitals, not have given to see only a glimpse of their Queen? What would it not have meant to thousands to be able to see her open Parliament per medium of their television receivers, had a service existed? It is to be hoped that the demonstrations have given the public at least some idea of what TV could do for them in their homes, for if, by some miraculous means they could be given full realization of the possibilities of TV, there is little doubt that a great demand would arise, and that New Zealand would soon have a television service through which not only the sound, but also the sight of great events could be brought to the peoples' homes. If at the moment no great public demand exists, it is only because the public does not realize the potentialities of TV. Demonstrations at fairs and in shops are at best a poor substitute for a real live service in one's own home, but those who have put on these demonstrations can at least take comfort in the thought that they are doing their best to enlighten the populace with regard to one of the modern seven wonders of the world, and that they are at least a little more progressive in their attitude than is the Government. We can only hope that their efforts do not go unrewarded, although we would certainly not care to make any predictions to the effect that the Government might shortly become alive to the value of television to the community.

THE "R. & E." 1954 HIGH-QUALITY AMPLIFIER



Here, after several months of development, is the final form, and practical realization, of some ideas which were put forward in two previous articles.

INTRODUCTION

In the July and September issues of this journal, there appeared two articles under the title "A Design for a High-quality Audio System." The first of these expounded some of our ideas about the general problem, while the second described a circuit which had been developed in our laboratory in order to test them in practice. We had hoped to follow on immediately with the article now being presented, but this was not possible, for a number of reasons. It is appropriate, therefore, if we apologise at this juncture to those enthusiastic readers who have eagerly been awaiting its publication.

In point of fact, the delay has turned out to be advantageous, since it has enabled us to develop the circuit further, by way of simple modifications which, while they have had no effect on the performance, have given it a considerable margin of stability. The effect of these modifications, therefore, is simply to make the amplifier easier to duplicate, and less critical in nature. Thus, in spite of the relatively large number of small parts used, the additional development work we have been able to undertake has resulted in an even better job than we had originally anticipated, and we think that the delay has been justified! As it is, we usher in 1954 with what we hope will turn out to be one of the most interesting designs to come from our laboratory.

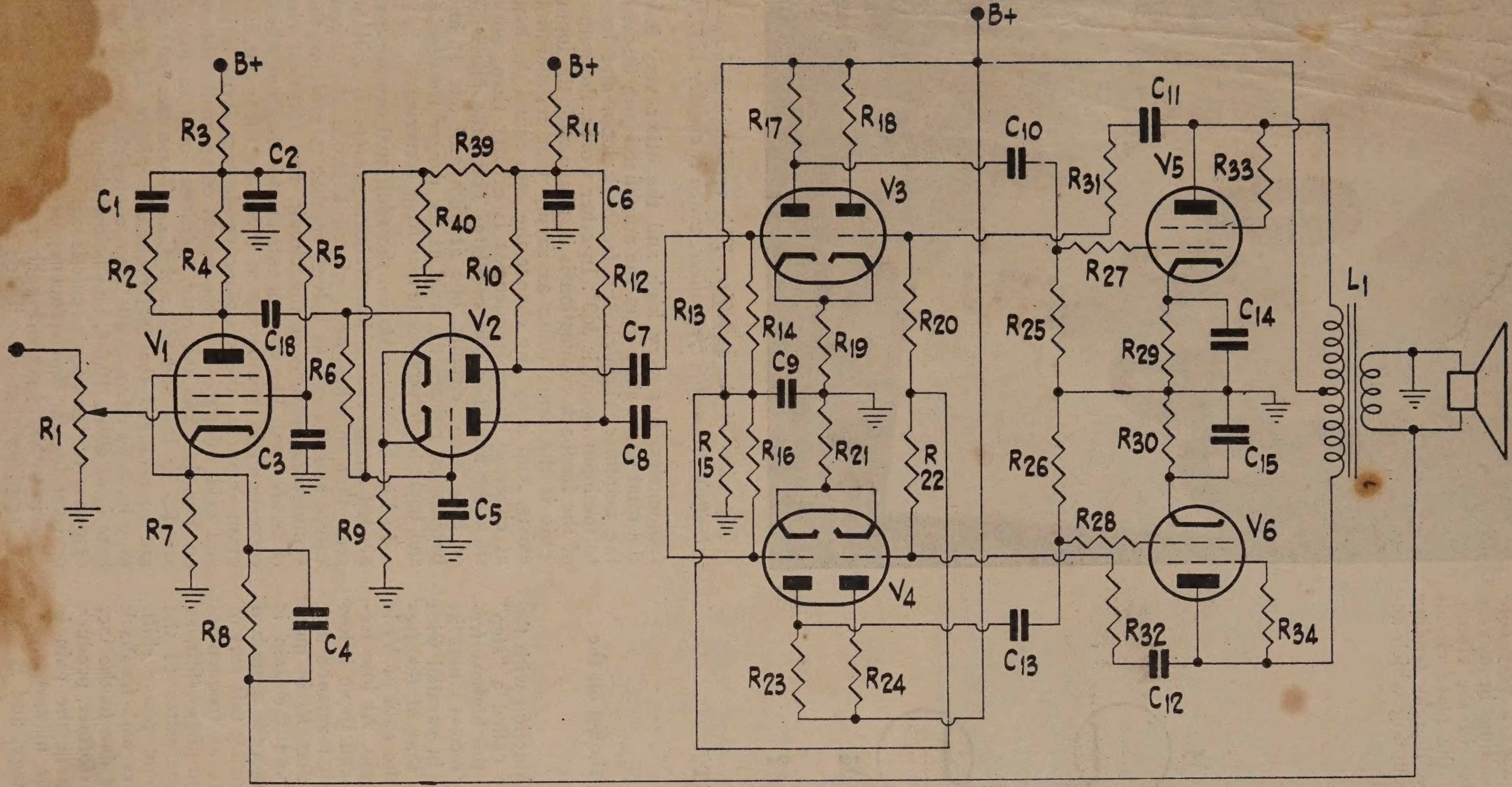
THE MAIN CIRCUIT

For the benefit of those who may not have the original circuit by them, we have reprinted it here. First of all, we should explain that we have made two alterations in it which may not too easily be "spotted" without having them pointed out. The first was to correct an error. In the original diagram, the blocking Condensers C_{11} and C_{12} were drawn in wrong positions. They should be connected as in the amended drawing, directly to the plates of V_5 and V_6, with R_{31} and R_{32} between them and the other resistors in the voltage divider—namely, R_{20} and R_{22}. Connected as originally drawn, the result would be a rather tremendous bass boost, not in the book, although the effect of this would be partially nullified by the overall feedback loop.

The other alteration concerns the direct coupling between the plate of V_1 and V_2. Originally, this was shown as a direct coupling, and was found to work very satisfactorily. However, it was thought safer to amend this, and insert a coupling condenser, which is shown in the new circuit diagram as C_{16}. This necessitated the provision of a voltage divider from the H.T. line, in order to supply the positive grid return voltage. This has been added in the redrawn version of the circuit shown here. It might be mentioned that, since the other circuit values connected with V_2 are almost identical with those of V_3 and V_4, the expedient was tried of returning the "spare" grid of V_2 through a decoupling resistor to the junction of R_{13} and R_{15}. This was quite satisfactory except in one respect. This was that after the amplifier passed the overload point, low-frequency instability set in owing to the fact that under grossly over-loaded conditions, the balance of the whole amplifier is destroyed, thus bringing about an entirely different set of conditions. In practice, this would make no difference at all, provided that the amplifier was not driven into overload at any time. This, however, is too much to expect, the human element being what it is, and to obviate the rather sudden break-up in quality which occurred, the separate grid return of V_2 was arranged. As a result, the amplifier behaves quite smoothly after the overload point has been reached. This may be regarded as somewhat of a refinement, but is the sort of minor point that one can reasonbly expect the designer to have taken care of if he claims really high quality for the result of his labours!

PREVENTION OF MOTOR-BOATING AND H.F. OSCILLATION

In devising this circuit, special care has been taken to ensure a high margin of stability with the recommended degree of feedback. To the constructor, this means that if his component values are not chosen to 1 per cent. accuracy (which in most cases they will not be) he will not on that account be plagued by instability, the amplifier either motor-boating or breaking into oscillation at some supersonic frequency. The circuit tricks used can be seen in the main circuit diagram, in the plate circuit of V_1, and also in Fig. 2. In the main diagram, the plate load resistor of V_1 is R_4, which has a value of 25k. The resistor R_3, of 100k., is merely a decoupling resistor,



COMPONENT LIST

R_1, 500k. volume control.
R_2, 2.5k.
R_3, R_{10}, R_{12}, R_{17}, R_{18}, R_{23}, R_{24}, 100k.
R_4, R_{20}, R_{22}, 25k.
R_5, 200k.
R_6, 1 meg.
R_7, 500 ohms.
R_8, main feedback resistor, 24k.
R_9, R_{19}, R_{21}, 60k.
R_{11}, 20k.
R_{13}, 1.25 meg.
R_{14}, R_{16}, 1 meg.
R_{15}, R_{25}, R_{26}, 500k.
R_{27}, R_{28}, 10k.
R_{29}, R_{30}, 600 ohms 5 watts.
R_{31}, R_{32}, feedback resistors, 1 meg.
R_{33}, R_{34}, 100 ohms.
R_{39}, 1 meg.
R_{40}, 500k.
C_1, 500 $\mu\mu$f.
C_2, C_6, 16 μf. 450v. electro.
C_3, 0.1 μf.
C_4, feedback condenser, 50 $\mu\mu$f.
C_5, C_{11}, C_{12}, 0.5 μf.
C_7, C_8, C_{10}, C_{13}, 0.1 μf.
C_9, 0.5 μf.
C_{14}, C_{15}, 50 μf. 50v. electro.
C_{18}, 0.1 μf.
V_1, 12J7 or 127GT.
V_2, V_3, V_4, ECC32.
V_5, V_6, KT66.
L_1 (should be T_1), Williamson Output Transformer, 9000 ohms to 15 ohms.

and, in conjunction with C_2, forms a filter circuit which has two functions. First, it adds a very considerable degree of smoothing, resulting in a very pure D.C. supply for the first valve in the circuit. Secondly, it very firmly decouples the plate circuit of this stage from the power supply, thereby tending to prevent the sort of inter-stage coupling which accounts for motor-boating.

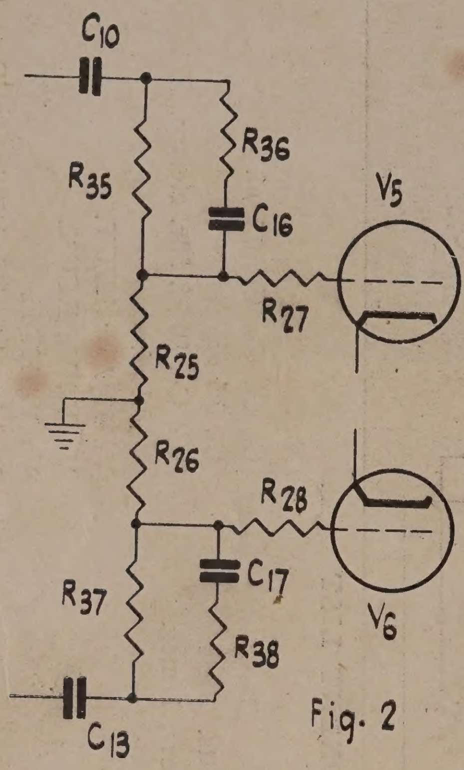


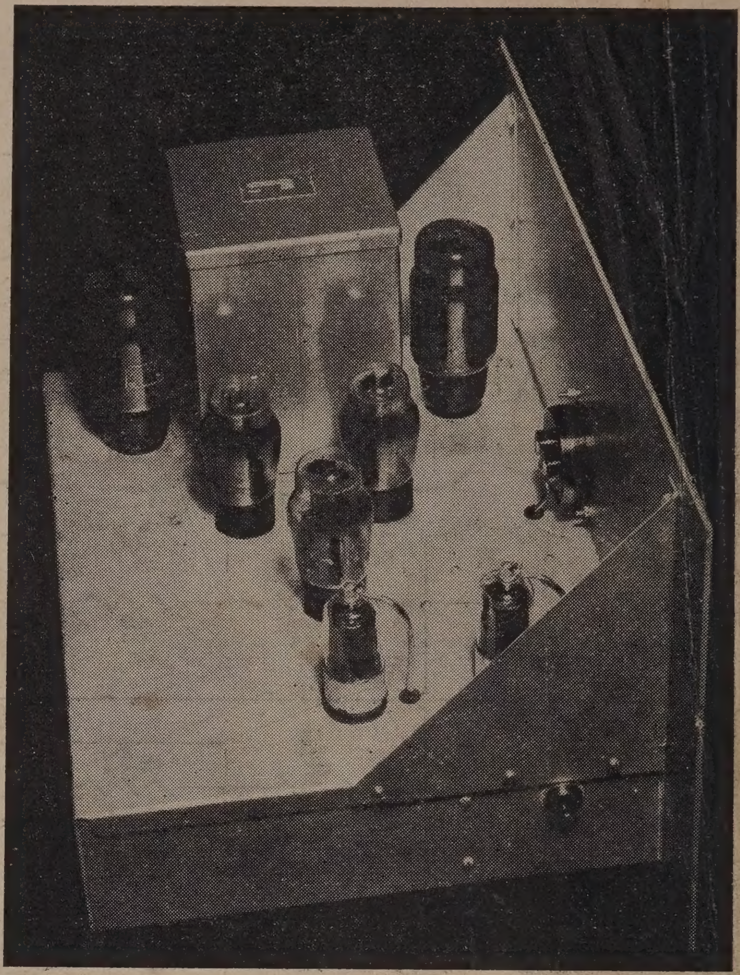
Fig. 2

COMPONENT LIST

R_{35}, R_{37}, 2 megs.
R_{36}, R_{38}, 50k.
C_{16}, C_{17}, 0.01 μf.

All other components are those shown on the main diagram.

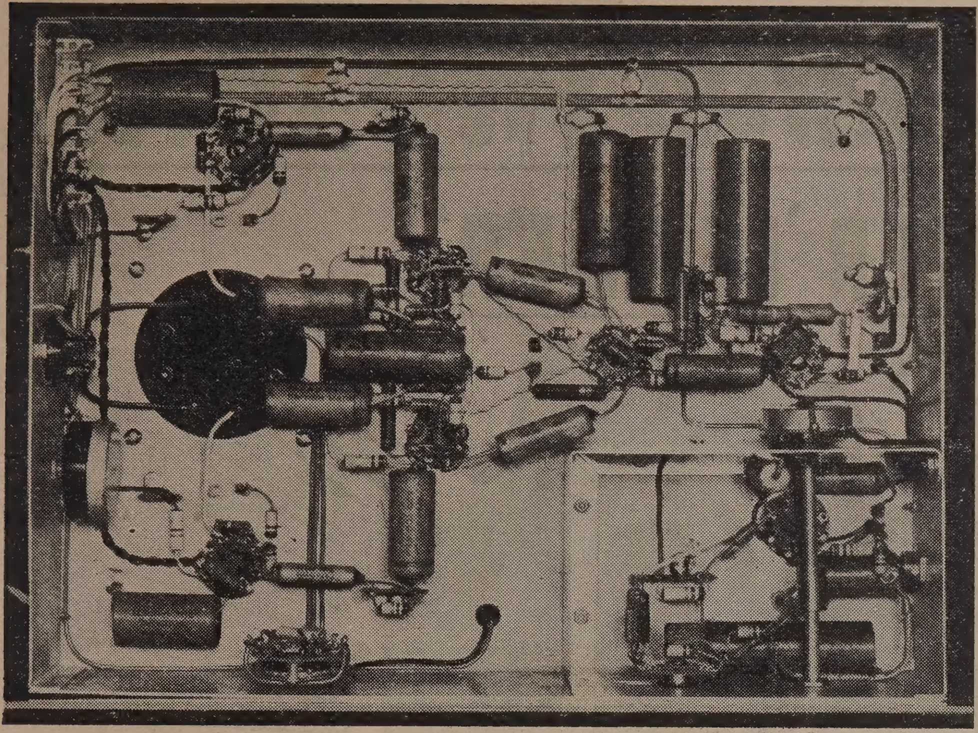
The components C_1 and R_2, in conjunction with the load resistor R_4, form what may be called a "step" circuit. It works in this fashion. At the highest frequencies—in this case, above 50 kc/sec.—C_1 acts as a short-circuit, effectively placing R_2 in parallel with R_4. Now, R_2 has a value of 5k., so that at the frequencies we have been considering, the gain of V_1 is only about one-fifth of its normal gain. At low frequencies, and for this purpose we mean those below about 15 kc/sec., C_1 has such a high reactance that it appears as an open circuit, so that R_4 is quite unaffected by the presence of R_2, and the gain is normal. In between these extremes, there is a gradual falling-off. A feature of circuits producing this sort of step in the response curve, is that at frequencies above and below this step, there is no phase shift, so that we have a device which approximates to the ideal of producing attenuation without phase shift. Now, all the difficulty about amplifiers with feedback turning themselves into oscillators, is due to the fact that every stage, and the output transformer, produce phase shift at those frequencies where the gain is falling off. Now, the phase shift due to each stage adds itself to that of every other stage, and at two



Top view of the amplifier. This version includes a built-in preamplifier/equalizer, which is another 12J7.

frequencies, one very high and the other very low, the total phase shift from the amplifier input, through the amplifier, through the feedback loop, and back to the input again, is 360°. In other words, the output of the feedback connection is in phase with the input. This is the same thing as saying that regeneration exists. And if by any chance the gain round the loop at either of these frequencies is greater than unity, then the amplifier will oscillate. Thus, the provision of two "step" circuits, one at high and one at low frequencies, reduces the gain at the danger frequencies, and tends to prevent oscillation from occurring.

In Fig. 2 we have shown the additional components needed to provide a low-frequency step. It will be seen that this has been placed between the driver valves and the output valves, so that to preserve the symmetrical nature of the circuit, two identical circuits are used. The components on this diagram which correspond in numbering to those on the main diagram—namely, the coupling condensers, grid leaks, and grid stoppers—are the actual components shown on Fig. 1. Thus the only additional ones in Fig. 2 are R_{35} to R_{38}, and C_{17} and C_{18}. These step circuits are so arranged that at frequencies above 25 c/sec. they have no effect at all. Then comes the step, which here is of about 10 db., and below about 8 c/sec., the response of the step circuit is again flat. This exact position for the low-frequency step was determined experimentally by placing so much feedback round the amplifier that it oscillated at low frequency. This



Underneath view. The shield partition in the front right-hand corner houses the preamplifier stage. The volume control (R_1 on the main circuit) is mounted on the back of the shield partition and operated through an extension shaft.

Below: The shunts S_1 and S_2 are each chosen so as to give the meter full-scale deflections of 100 ma. In the centre switch position, the shunts are in parallel, giving an F.S.D. of 200 ma. In this position, the curents of both output tubes are being measured.

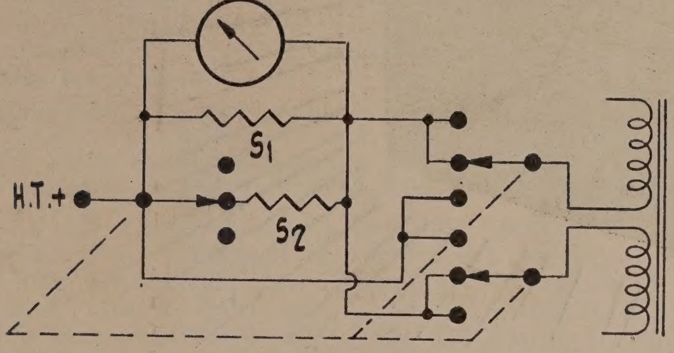


Fig. 3

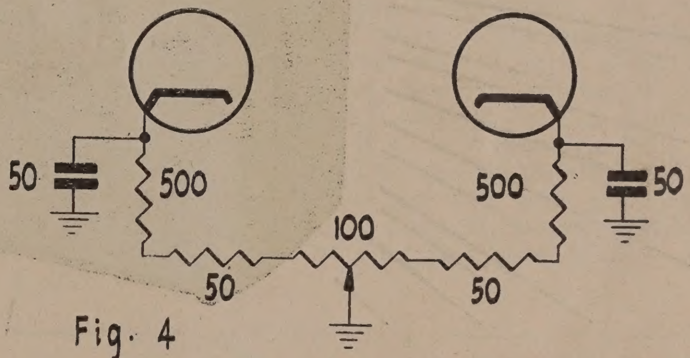


Fig. 4

was found to be in the vicinity of 1 c/sec.—an indication that the low-frequency response of the amplifier, both as regards amplitude and phase, was excellent. In addition, it showed that the step was required to become fully effective at some frequency considerably higher than 1 c/sec. In case 8 c/sec. may not seem very far removed from this, we should point out that this is the ratio of the two frequencies, not the difference in cycles per second that counts when we are assessing the performance of an amplifier or network. On this basis, it is seen that 8 c/sec. bears the same relation to 1 c/sec. as 8000 does to 800! After the step circuit had been incorporated, it was found that considerably more feedback could be applied before motor-boating took place. This means that with the amount of feedback recommended by the circuit values, which are now given in full, the step circuit provides a substantial safety margin. This will take care of such things as unbalance between the two halves of the amplifier as resistors change their values with age, or as valves age differently. An amplifier is hardly a success if it works properly only with brand-new tubes, or with resistors chosen with extreme care, as has been pointed out in earlier articles of this series.

Those who may have already built the circuit as originally given and who have it working satisfactorily would be well advised to make the modifications discussed above, if only for their insurance value, which is considerable.

OTHER ADDITIONS

The version of the amplifier illustrated here was built for professional use, and so incorporated two additions which might not be considered essential if it is built for home use. The first of these was to add a metering circuit, shown in Fig. 3. This enables the plate current of either output tube to be read individually, and, in the third switch position, gives the total plate current. In normal use, this position can act as an indicator of overloading if the amplifier is being run near maximum output, because, when overload is approached, a slight upward flicker of the meter is seen, while more severe overload results in a downward kick after the initial rise. The individual valve currents kick about a little, before any move-

(Continued on page 48.)

QUESTIONS AND ANSWERS

HOW A BASS-BOOST CIRCUIT WORKS

J.B., of Sydney, sends us the drawing shown in Fig. 1, and asks: "Would you please explain how the values of C, R_1, R_2, R_4, and C_2 are calculated for a boost of 6 db. per octave."

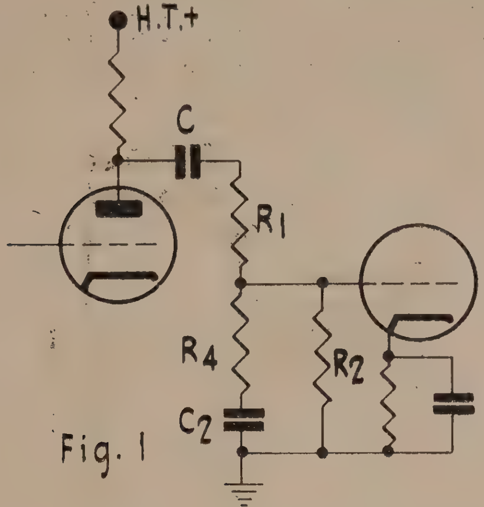


Fig. 1

This is a question which has probably exercised a good many of our readers, even if they do recognize the circuit as one of giving bass boost. It represents a standard method of doing this, especially for such purposes as pick-up equalization, when the amount of boost is fixed. Knowing just how the arrangement works can be very useful, as it can make one independent of copying someone else's circuit, which may not suit the purpose in hand. So here goes.

As J.B. clearly suspects from his question, all the components mentioned can affect the frequency response. In practice, however, things are arranged so that C and R_2 have only a negligible effect. Their only purposes are blocking the D.C. from the grid of the second valve, and providing a D.C. grid return, respectively. We will therefore ignore them for the moment and concentrate on the remaining components. With C and R_2 out of the picture, the circuit boils down to that of Fig. 2, which doesn't look half

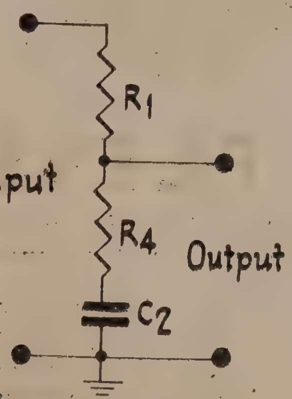


Fig. 2

so fearsome, and contains only three components. In order to see how the boosting effect comes about, let us take the cases of two frequencies, one high and the other low, and see what happens to them on passing through the network. The condenser C_2 appears like a short-circuit to a very high audio frequency, as its reactance is very low, so that the net-

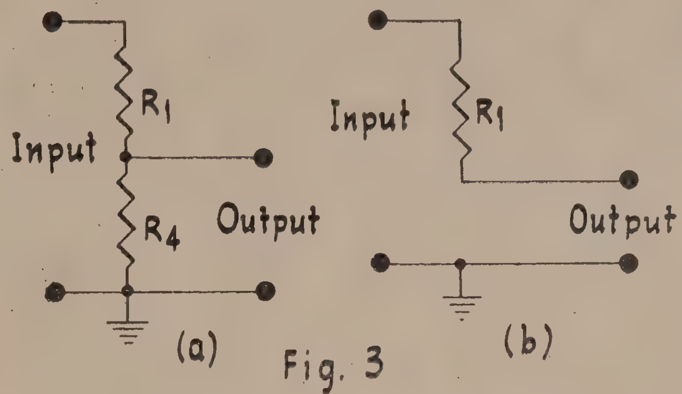


Fig. 3

work reduces to that of Fig. 3 (a) at high frequencies. This is a simple voltage divider, and so at all frequencies that are so high that C_2 looks to them like a short-circuit, the output is constant, and equal to a fraction of the input voltage. The size of this fraction is determined solely by the ratio of R_1 to R_4, and is numerically equal to $R_1 \div (R_1 + R_4)$.

At very low frequencies, C_2 looks like an open circuit, because its reactance is very high, and under these circumstances, the whole of the input voltage is applied to the grid of the second valve. From the above, it is not hard to see that the amount of low-frequency boost is determined only by the values of R_1 and R_4. For example, if R_1 is 9 times R_4, then the high-frequency output will be exactly one-tenth of the low-frequency output, and we will have a boost of 20 db. If R_1 is equal to R_4, the H.F. output will be half the L.F. output, so that the boost is now only 6 db.

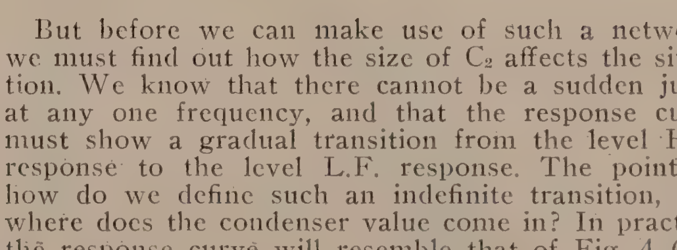


Fig. 4

But before we can make use of such a network, we must find out how the size of C_2 affects the situation. We know that there cannot be a sudden jump at any one frequency, and that the response curve must show a gradual transition from the level H.F. response to the level L.F. response. The point is, how do we define such an indefinite transition, and where does the condenser value come in? In practice, the response curve will resemble that of Fig. 4 (full line). Broadly speaking, we can expect the effects due to C_2 to come at higher frequencies, the smaller C_2 is, so that a large C_2 will give a response following the full line, while a smaller C_2 will give one following the dotted one.

In networks like this which contain capacity or inductance, it is standard practice to define the place

where boost starts or ends as the frequency at which the response is 3 db. down (or up) on the nearest level patch. For example, we would say that the boost on the full curve starts at f_1 and ends at f_2. The 3 db. is used instead of any other figure because it is so convenient. If the response of the network is worked out by strict mathematics, it is found that the 3 db. rise (or drop) points always come at a frequency such that the reactance of the condenser is equal to a certain value of resistance to be found in the circuit. For example, f_1 is the frequency at which the reactance of C_2 is equal, in ohms, to the resistance of R_4. Also, f_2 is the frequency at which the reactance of C_2 is equal to the resistance of $(R_1 + R_2)$. Now, the reactance of C_2 is inversely proportional to frequency, so that if we calculate the reactance of C_2 at either frequency, we find the other frequency very readily. For example, supposing that f_1 is 300 c/sec., and R_1 and R_4 are 250k. and 25k. respectively, then $(R_1 R_4) = 11R_1$, and f_2 must be one-eleventh of f_1, or 27.3 c/sec. The total boost between the flat portions of the curve will be 11 times, or 21 db., so that the boost between f_1 and f_2 must be $21 - 6 = 15$ db.

Now for the bit about 6 db. per octave. As in music, an octave represents a frequency ratio of 2 to 1. Now, it is well known that any sloping portion of a response curve which is caused by a single condenser ultimately reaches a slope of 6 db. per octave. Thus, the only thing about the present circuit which determines whether the sloping bit actually has this slope at any part of it, is the maximum boost attainable. The slope can never be greater than 6 db. per octave, since only one condenser has been used, and for small amounts of total boost it obviously cannot reach this slope (e.g., if the boost is 6 db. or less). From the practical point of view, however, the exact slope attained matters very little. We have given enough information in this reply to enable J.B. or anyone else to design his own boost circuits.

As for C and R_2, if these are not to affect the frequency response we have been at some pains to provide, the following conditions must be met. (1) The reactance of C must be large compared with the value $(R_1 + R_4)$. This is just the same condition that C must fulfil if it is an ordinary coupling condenser, and there were no boost network at all. (2) R_2 must be much larger than R_4, and preferably much larger than R_1 also. If it is not, then the maximum boost will be considerably less than our previous calculation suggests, owing to the voltage-divider action of R_1 and R_2 at low frequencies.

For a 78 r.p.m. pick-up equalizer, suitable valves would be: R_1, 100k.; R_2, 1 meg.; R_4, 10k.; C_2, 0.1 μf.; and C, 0.5 μf. Note that R_2 cannot be made any larger than 1 meg., because the valve makers stipulate this as the maximum grid resistance. This limits R_1 to about 100k., to preserve the condition that R_2 must be much greater than R_1. This fixes R_4 at about 10k. because we want a maximum boost of about 20 db. In the region of 300 c/sec., the impedance from the top of R_1 to earth is not much more than 100k., so that C must be large if it is not to affect the response curve.

* * *

FEEDING A DIPOLE FROM COAXIAL CABLE

From the same correspondent comes a second query which we think will interest a good many of our amateur readers. It concerns the best method of feeding a dipole at the centre, using 72-ohm coaxial cable. The frequency is 14 mc/sec. In addition, our corespondent wants to know what losses would be sustained if 50-ohm coaxial were used instead, realizing that this does not match the 72 ohms at the centre of a half-wave dipole.

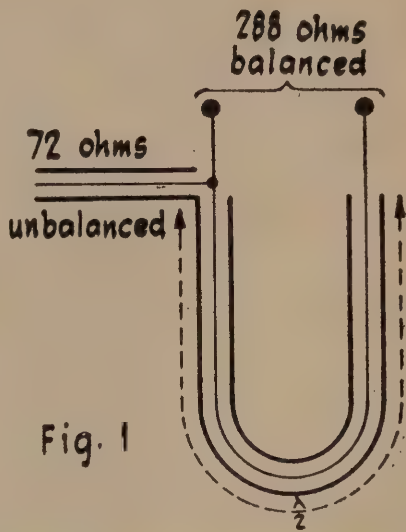


Fig. 1

Now, this question of aerial feeding and matching is one which is presented in all the popular textbooks as a more or less cut-and-dried one. However, in the interests of simplification, these books often omit things which have a marked practical bearing on the subject. Take, for example, the feed-point impedance of a dipole excited at its centre. This is always stated to be 72 ohms. One would not expect there to be much argument about this. But it is true only in certain isolated cases. One is when the dipole is so far removed from the earth that it can be regarded as in free space. Not a very practical or attainable condition. Actual measurements show that the input impedance is quite widely variable, depending (a) on whether the dipole is vertical or horizontal, and (b) on the distance of its centre above the earth.

For a horizontal dipole, for example, erected at a height of 0.35λ above the ground, the resistance is 100 ohms. At 0.5λ, it is the "official" 72 ohms, while at 0.62λ it is as low as 60 ohms. Then, again, we must take into account such things as the proximity of other objects such as trees and buildings, so that, by and large, the input impedance of the dipole is pretty much an unknown quantity, and is liable to have any of quite a range of values. The extent of this range shows, however, that the best all-round value to use as a basis for calculation or experiment is that of 72 ohms. We might thus expect a 72-ohm coaxial line to have the best possible chance of matching a dipole. Unfortunately, however, the dipole is a balanced device, with both input terminals above ground, and like all such should be fed with equal and out-of-phase voltages at the two feed points. Coaxial cable, on the other hand, is unbalanced, which means that one terminal is, or should be, always at earth potential. Here is the crux of the difficulty. If coaxial cable is to be used to feed a dipole, we must do one of two things. Either the coaxial must feed first into some gadget which converts its unbalanced output into a balanced one, or else the inner conductor must be connected to one of the dipole's feed points, and the outer to the other. In the latter case, it is obvious that neither the dipole nor the cable will be properly terminated, and what will happen is that the outer conductor of the cable will develop voltages on it.

This scheme can be used, and will not result in much loss provided that the cable runs away from the aerial at right-angles for at least half a wavelength, and preferably farther. The main departure from theoretical performance will be found not in greatly increased losses, but in the fact that there will be considerable vertically-polarized radiation from the feeder line. Unless you have plenty of cable to spare, this is probably the best system to use, as being the cheapest and requiring least adjustment.

The simplest type of balanced-to-unbalanced converter is shown in Fig. 1. This is self-explanatory, and it can be seen that the impedance at the balanced output terminals is four times that of the coaxial line, and so very nearly 300 ohms. Thus, if this scheme should be used, it can be directly connected to a folded dipole and a very good match will be obtained. To connect it to a single-wire dipole, it would be necessary to insert a matching transformer, consisting of a length of two-wire line, $\lambda/4$ long, and having a characteristic impedance of 144 ohms.

Our correspondent has some more questions relating to the same topic, but space prevents us from answering them in full this time. They will have to be left till another issue.

Phase Shift Method of Checking Distortion

By the Engineering Department, Aerovox Corporation

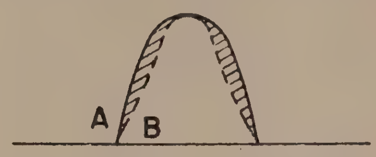
Interest in high-fidelity audio has experienced a phenomenal growth during the past ten years. For many years, the transmitting radio amateurs comprised the largest known group having an avocational interest in electronic equipment. Today, however, authorities estimate that high-fidelity enthusiasts outnumber the "hams." The reasons are fairly obvious. In the first place, the audio-hobbyist does not need to meet any licence requirements. The inevitable weeding-out process of a technical examination therefore is absent and a larger number of people automatically become free to pursue their interests. Secondly, audio is closely associated with the enjoyment of good music, something in which an entire family can participate.

The critical audio technician applies exacting tests to his equipment. One such test is **distortion measurement.** This test is of prime importance, since it rates directly to the fidelity of the examined equipment.

PRIOR MEASURING TECHNIQUES

Standard methods of measuring harmonic distortion have, up to this time, used some variation of the following technique: (1) a sine-wave signal of exceptional purity, having a desired frequency, is applied to the input terminals of the amplifier or other device under test. (2) The amplifier output then is applied to a test circuit in which the fundamental test-signal frequency is suppressed by an appropriate band-elimination filter. (3) Assuming that no harmonics were present in the test signal, the filter would have zero output voltage. Any harmonics actually present at the output of the tested device would pass through the filter, since the latter is tuned to remove only the fundamental, and would show up as a measurable filter-output voltage. This voltage may then be construed to indicate that the tested device has distorted the originally pure test signal. (4) This distortion voltage is measured, and the harmonic distortion percentage determined from the ratio of harmonic voltage to the total fundamental and harmonic voltage. For this purpose, the two voltages might be measured before and after the filter. The measurement is made with an oscilloscope or A.C. vacuum-tube voltmeter. Several test frequencies through the audio spectrum are employed. This system is the basis of all commercial harmonic distortion meters which indicate **total distortion.**

Several difficulties confront the technician in the actual practical application of this method. First, and very important, a pure sine-wave test-signal source is an absolute requirement. An oscillator or audio signal generator meeting this specification seldom is found outside of the advanced laboratory and is an exceedingly expensive instrument. Indeed, many high-priced audio oscillators are not completely satisfactory for the purpose. Attempts to correct for the inherent distortion of the average oscillator often give rise to a number of inaccuracies, because of involved mathematical relationships. Furthermore, the distortion tests are complicated and delayed when corrections must be made. The second important difficulty concerns the filters. Ideally, a distortion filter must attenuate the fundamental frequency completely, while transmitting all of the harmonics with no attenuation. **The farther you fall from this goal,** the greater will be the error due to residual fundamental or attenuated harmonic voltages. A filter having sufficiently sharp cutoff and low enough attenuation of the harmonic frequencies to permit distortion measurements lower than a few per cent. must be designed critically and must be constructed with expensive high-Q components. The third difficulty has to do with the indicating instrument. For best results, this should be a **full-wave** square law A.C. vacuum-tube voltmeter, not a common type.



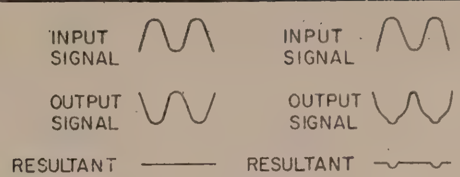
SINE-WAVE INPUT (A) COMPARED WITH DISTORTED OUTPUT (B) OF SAME PEAK AMPLITUDE

FIGURE I.

Aside from harmonic distortion checking, the measurement of **intermodulation distortion** has received considerable attention during recent years. This is a measurement of the interaction between signals of two different frequencies passed simultaneously through an amplifier or other device under test. Intermodulation tests are favoured in many quarters, since they seem to correlate more closely with actual listening tests. In one system of intermodulation testing (the one credited to the Society of Motion Picture and Television Engineers, SMPTE), a low- and high-frequency signal are applied simultaneously to the tested device. If the latter has none of the non-linearities which give rise to discords and dissonances in the output, the two signals will be delivered with no interaction between the two. If this is not true, the output will consist of the high-frequency signal amplitude-modulated by the low frequency. The technique of determining the degree of modulation then consists of the following steps: (1) The modulated high-frequency component is separated by means of a high-pass filter. (2) It then is demodulated and the average value of this signal set to a predetermined reference level by means of a gain control. (3) The low-frequency envelope of the demodulated signal finally is separated by means of a low-pass filter and its amplitude measured with an A.C. vacuum-tube voltmeter calibrated in intermodulation percentage.

Difficulties also confront the technician in applying the intermodulation method and in interpreting the results obtained. The required high-and low-pass filters must have sharp cutoff to prevent interference from the eliminated band of frequencies, and flat transmission throughout the pass band. This requirement dictates costly, high-Q filters. Also, there is at present, lack of standardization with regard to the test-signal amplitude ratio, the signal frequencies

to be used, and uniform rating of amplifiers in terms of intermodulation percentage. Furthermore, separate tests must be made at a number of combinations of low and high test frequencies, in order to compensate for the amplifier frequency response. It accordingly is insufficient to state that an amplifier has a certain percentage of intermodulation—one must say at what frequency combination the test was made and also with what signal amplitude ratios. There is no simple arithmetic relationship between the intermodulation percentage and a "corresponding" amount of harmonic distortion.



(A) UNDISTORTED OUTPUT (B) DISTORTED OUTPUT

EFFECT OF MIXING INPUT AND OUTPUT WAVES WITH 180-DEGREE PHASE DIFFERENCE

FIGURE 2.

VIEW OF THE PROBLEM

An amplifier should be a linear device. Otherwise, it cannot be a faithful reproducer. By linear, we mean that the output signal should follow the input signal **directly.** If the input is doubled, for example, the output also should increase by twice its original value. As the input signal waveform goes through its many positive and negative values, the output waveform should go through **similar** variations, although at higher amplitude (being amplified). All distortion, whether viewed as hormonic, phase, or intermodulation, is a matter of output waveform departing from that of the input signal.

It follows from these remarks that a check of amplifier linearity (output versus input) should establish a great deal with respect to fidelity. Such a test can be performed with any input signal—no expensive, high-purity generator is needed, since a high-fidelity system should reproduce faithfully even a distorted wave applied to its input terminals. Also, elaborate output filters would not be required.

One method would be to apply, at each selected test frequency, a series of input steps, and to check the corresponding output voltage steps. If the output voltage then is plotted against input voltage a straight line will be obtained for a true high-fidelity amplifier, having no distortion. If the line is not straight in any particular, the percentage whereby it deviates from the true linearity is an indication of the distortion present. And such non-linearity can give rise to harmonic, phase, and intermodulation distortion.

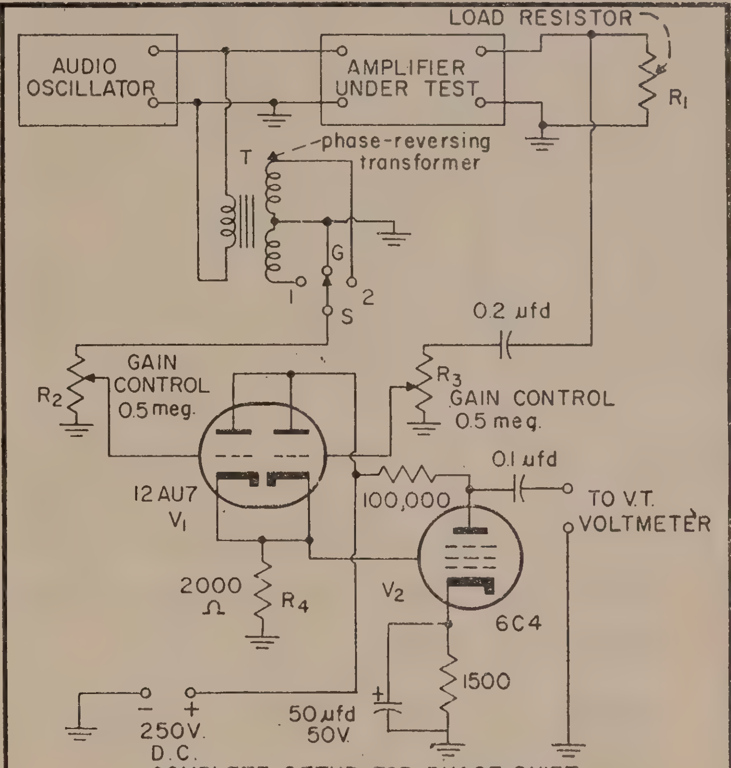
The foregoing point-by-point method of linearity checking is laborious. It is especially tedious if measurements are to be made at a number of test frequencies and at various settings of volume and tone controls in the amplifier.

Rapid, automatic methods of making this test are therefore desirable. The following paragraphs describe circuits and methods for accomplishing this purpose.

THE PHASE-SHIFT METHOD

Assume that a sine-wave test signal is applied to the input terminals of an amplifier under examination. One half-cycle of the input signal is shown as A in Fig. 1. Now, if the output signal of the amplifier is adjusted to the same peak amplitude and viewed on the same axis as A, provided it is of the same phase, it might appear as B in Fig. 1. The area under curve B minus the area under curve A would indicate the amount of deviation of the output signal waveform. And if this difference is divided by the area under curve A, the distortion percentage would be indicated. The shaded area in Fig. 1 shows the difference between the two areas.

Distortion may be checked in this manner by examining the amplifier input and output signals successively on the screen of an oscilloscope, being careful to adjust the two signals to the same peak amplitude. For each comparison, the patterns may be pencil-traced on thin paper or may be photographed by double exposure. This scheme requires that both input and output signals be of the same phase, sometimes necessitating the use of a suitable phase-shifting resistance-capacitance network in case the amplifier under test shifts the phase in the undesired direction.



COMPLETE SETUP FOR PHASE-SHIFT METHOD OF DISTORTION MEASUREMENT

FIGURE 3.

In the phase-shift method of distortion measurement, the input signal is reversed 180 degrees with respect to the output signal, and the two signals mixed after they are adjusted to equal amplitudes. If there is no distortion, the two signals being equal in amplitude and opposite in phase (see Fig. 2A) will cancel, giving a zero resultant. If, on the other hand, the output signal is distorted, only those portions of the output signal which are equal and opposite to the input signal will cancel. The other portions, representing distortion (variations from true linearity) will remain, as shown in Fig. 2B) and can be measured with an A.C. vacuum-tube voltmeter or oscilloscope.

The peak amplitude of the distortion components remaining at "null" may be compared with the peak

amplitude of the output signal (with the input signal removed temporarily from the mixing device) to determine the distortion percentage.

If the test oscillator signal is distorted, the two signals still will cancel each other, giving zero resultant, if no **additional** distortion has been introduced by the amplifier. The reason for this is that (initial distortion included) the input and output signals will be equal in amplitude and opposite in phase in all parts.

Figure 3 shows a typical complete set-up for checking amplifier distortion by means of the phase-shift method.

In this arrangement, the 12AU7 mixer tube, V_1, receives signals from the oscillator and from the amplifier output. The amplifier is terminated with a non-inductive load resistor, R_1, which has an ohmic value equal to the rated output impedance of the amplifier and rated to withstand at least twice the normal power output of the amplifier.

The input signal level into the mixer is adjusted with the gain control, R_2, and the level of the output signal by means of the second gain control, R_3. These controls are adjusted to make the two signals, as presented to the 12AU7 grids, exactly equal in amplitude.

A 180-degree phase reversal of the input signal applied to the mixer is obtained through transformer T. This must be a high-quality transformer of the high-fidelity type. An interstage component designed for operation between a single plate and push-pull grids is satisfactory. Switch S allows selection of the proper phase for bucking action in the mixer stage.

The cathode output of the mixer is applied to the grid of a 6S4 distortion-products amplifier, V_2. When there is no distortion in the amplifier under test, the 12AU7 output will be zero. Output of the 6C4 is applied to an A.C. vacuum-tube voltmeter or oscilloscope for measurement of the distortion voltage and examination of its waveform.

The set-up, as shown, will give satisfactory results in the majority of applications. However, when phase shifts within the amplifier (or network) under test are not of the order of magnitude other than those encountered in conventional amplifiers, it may become necessary to insert a simple R-C phase-shifting network, designed for use at the test frequency, in series with one of the signal leads to the 12AU7 stage.

The instrumentation is operated in the following manner: (1) Set the oscillator output voltage to drive the test amplifier to its full power output (output watts $= E^2/R_1$; where E is the voltage measured across load resistor R_1 with a high-impedance-input A.C. vacuum-tube voltmeter). (2) Connect an oscilloscope or A.C. vacuum-tube voltmeter to the 6C4 output terminals. (3) Adjust gain controls R_2 and R_3 for null — minimum deflection of the meter or 'scope. (4) If complete null cannot be obtained with switch S in its position 1, throw to position 2 and readjust the gain controls. Select the setting of switch S which gives the lowest reading. (5) Read any voltage remaining at the best obtainable null and record this as E_1. (6) Remove the oscillator voltage from the 12AU7 by setting switch S half-way between its two

contacts and thus grounding the grid. (7) Read the voltage then indicated by the meter. This is the full amplifier output including distortion components, and must be recorded as E_2. (8) Determine the distortion percentage (D) by means of the formula: D (%) = 100 E_1/E_2.

There is an advantage in employing an oscilloscope as the 6C4 output indicator. The 'scope permits an examination of the signal waveform, as well as its peak voltage value. This often is invaluable in determining the nature of the distortion and helps to determine what remedies should be applied for its correction. It is good practice to use the 'scope even when a v.t. voltmeter also is in the circuit.

The step-up shown in Fig. 3 illustrates the basic essentials of any circuit for checking distortion by the phase-shift method. Many variations are possible, and the reader may introduce obvious refinements which might appeal to him. An entire distortion meter might be constructed, for example, with a self-contained power supply and built in v.t. voltmeter or miniature oscilloscope. It is possible also to build the distortion meter into the same case with an audio oscillator, so that patch connnections need to be made only from the oscillator output to the amplifier and from the amplifier output back to the instrument.

We believe that the phase-shift method of distortion checking does a creditable job in a reasonably foolproof manner and recommend this method, or some variation of it, to the serious audio experimenter unable to afford expensive fidelity testing equipment. Components, such as transformers, couplers, etc., may be checked, as well as amplifiers.

No. 12

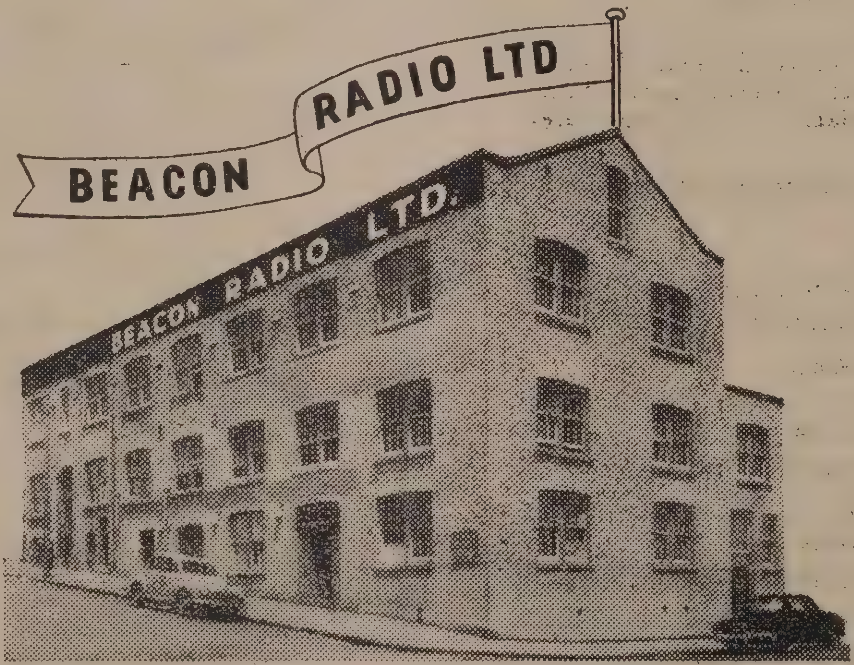
LABORATORY NOTES
from
BEACON RADIO LIMITED

ULTRALINEAR OUTPUT TRANSFORMER

Considerable interest has recently been taken in the American ultralinear version of the famous Williamson amplifier. A reduction in distortion and a considerable increase in power output over that of the Williamson amplifier has been claimed by the originators of the circuit. As in the Williamson amplifier, a major part is played by the design and construction of the output transformer. BEACON make a transformer rated at 30 watts which will work well when used in an ultralinear circuit. Screen taps are available so that pushpull KT66 valves, or similar types, may be used as pentodes with a sharing of load between screens and plates. The frequency response over the audio frequency band is excellent. We recommend this transformer for use in amplifiers where greater power output than that obtainable from the normal Williamson amplifier is required.

Cat. No. 53 S 66, 30-watt ultralinear output transformer

6,600 ohms P to P to 1-4-9-16 ohms



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THE APPLICATIONS OF TELEVISION IN INDUSTRY

By W. L. HARRISON, B.E., B.Sc., A.M.I.E.E.

An address given to the Electrical Section of the New Zealand Institution of Engineers at Wellington on September 16, 1953.

PART II
DEVELOPMENT OF INDUSTRIAL EQUIPMENT

Many of the early television pioneers felt that this new technique in which they had so much faith would find its most important applications in science and industry, but the very rapid way in which television has developed as an entertainment medium in recent years has tended to overshadow these early predictions. The industrial engineer tends to regard television as a highly exotic and temperamental device, and the result has been that industrial applications have been regarded with some suspicion. On the other hand, over-enthusiasm from a few engineers who sensed in it a technique of value has led to some applications for which simpler alternative solutions are available.

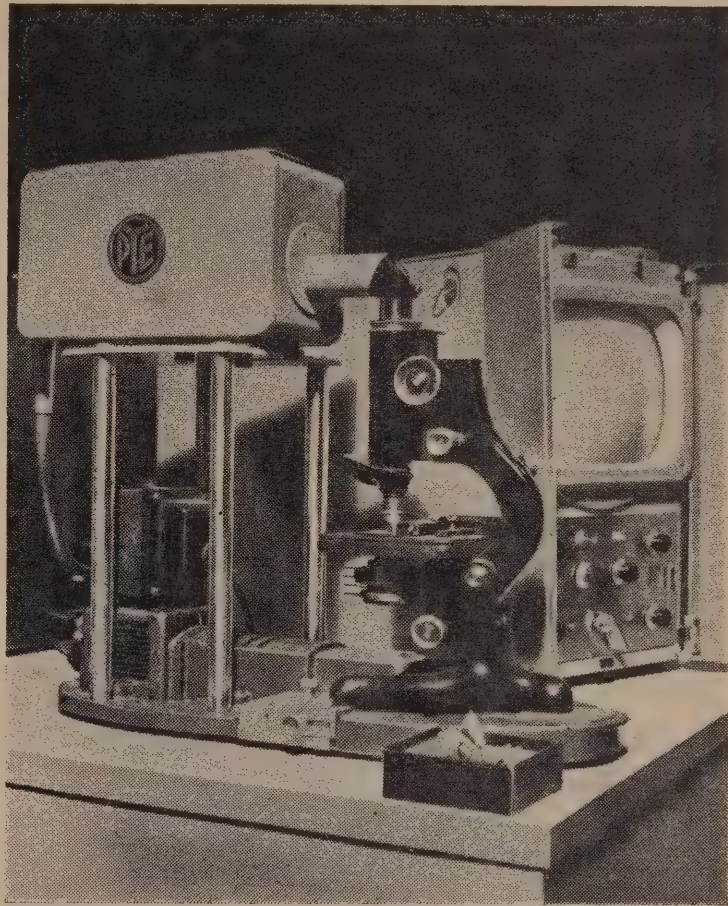
The complexity and cost of the establishment of a television station with its associated studios, control rooms, racks of equipment, lighting and audio facilities, cameras, film projectors, transmitter, and antennae, to say nothing of the great number of technicians and production personnel, could easily cause an industrial inquirer to hesitate before venturing into this field. Obviously, the first steps to be taken in winning the confidence of the industrial customer are to simplify the equipment, make it small, portable, and reliable; and to offer it at a price which can justify it economically for the selected industrial application.

The principal manufacturers of television equipment are now directing development along these lines. As an example of this, the Radio Corporation of America has produced a Vidicon Camera weighing only 7½ lb. and about the size and shape of a 16 mm. movie camera. The dimensions are approximately 10 in. by 5 in. by 3½ in., and it uses the standard 16 mm. camera lens. This is a contrast to the usual television studio camera, which is about 18 in. by 12 in. by 10 in. and contains a multiplicity of electric valves and components.

If the distance between the camera and the reproducing unit is not very great—as would be the case in most industrial applications—the radio transmitting and receiving equipment, usually a part of television, is not required. Instead, the two units can be directly connected by a cable of the low-loss coaxial type. This makes the equipment much cheaper to purchase in the first place and much simpler and less costly to maintain in operation.

If extreme mobility of camera is required, however, free of connecting cables, then a radio link can be used. R.C.A. has developed a lightweight Pack Set which they have termed a "Walkie-Lookie" (after the portable radio telephone "Walkie-Talkie"). The camera measures 8 in. by 3 in. by 6½ in. high and weighs only 7½ lb., including the three turret-mounted lenses. Associated with the camera and connected to it by a 4 ft. cable is a Pack unit to be carried on the cameraman's back.

This contains the amplifiers and associated equipment for the camera together with a small radio transmitter operating on the V.H.F. band on 2,000 megacycles/second. All are operated by batteries located in the Pack, which has an all-up weight of 51 lb.



This photograph shows the set-up of TV camera and microscope used for the "TV microscope." The display unit can be seen behind the microscope, and the enlarged picture appears on its C.R.T.

The "Walkie-Lookie" can work over distances up to half a mile.

INDUSTRIAL APPLICATION OF TELEVISION

There are many operations in industry and research where visual observation and control are necessary, but which are uncomfortable or hazardous for the operator or person in charge. Such processes may be watched in detail by means of the television camera—in fact, by means of the telephoto lens they may, in many cases, be seen with greater detail than is possible by a human operator. The camera is able to face with impunity heat and fumes too intense or dangerous for a human being. It can look unblinkingly into the fiery furnace and transmit a clear view of combustion and slagging conditions; it can face the white heat of molten steel and, in many ways, can take part in operations where, perhaps due to a slip, mishap, or miscalculation, a human life may be lost.

One industrial television manufacturer puts the advantages of television like this:

"If the handling is too dangerous, too inaccessible, too far, too high, too dark, too tiring, too inconvenient, too scattered, or too expensive to observe directly, you should consider television."

The following are some examples of the current uses of television in industry:—

Pouring Molten Steel

Before the use of television, a workman had to be stationed at the mould to watch the pouring operation and to signal the control operator some distance away.

Conveyor Control

A coal company uses television to safeguard against coal pile-ups at the remote end of the conveyor just out of sight of the operator.

Smoke and Boiler Control

Television is used for the control of smoke from the factory and power-plant chimneys and for watching water levels in vital boiler installations. These in some cases may be many floors above the location of the control panels.

Milling Operations

In hazardous milling work, television can give constant oversight of dangerous rolling-mill operations. In one installation there are ten cameras enabling perfectly safe remote control of many operations simultaneously.

Furnace Control

Television is employed at a power station for remote viewing and control of furnace-lighting procedure. In this particular installation the functions performed are:

(1) Preparatory to lighting off, to show that all ignition torches which are operated from the control tower are ignited.

(2) In lighting off, to show that ignition of oil or coal has taken place and is stable.

(3) To show improper operation of burners or loss of ignition at any time.

(4) To show any condition that might result in a furnace explosion.

Telemetering

One most important application is that of telemetering, or means whereby remote indications may be made of electrical or other quantities. With the television camera, meterings can easily be brought to a central point. Instruments for measuring voltage, current, power, temperature, pressure, etc., being used in dangerous experiments can also be watched from a position of safety.

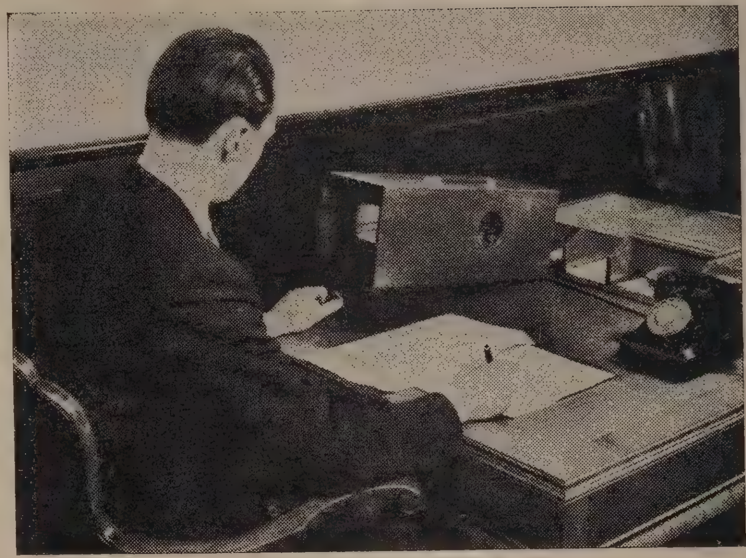
Chemical Plants

Some chemical plants and explosive factories also use television to limit the hazard of personal injury.

Forest Fires

Strategically placed cameras have already been given the job of guarding large areas of pine forests from fire, and for watching levels of water in tanks and reservoirs.

Because of the sensitivity of the television camera to infra-red light, there are many applications where this instrument can see instantaneously and almost



Showing a small TV screen mounted on a banker's desk to enable him to check signatures, etc., on documents situated at the remote camera point.

without hindrance through smoke and fog which would baffle the human eye.

Sales Exhibits

Television may be used to advantage in sales. By means of a number of cameras in various sections of large departmental stores, it is possible for customers to have a preview, at certain selected positions, of goods, bargains, special features, and exhibits, etc., scattered on different floors throughout the building. Customers can thus be shown the upper floors and any other sections of a store which they seem reluctant to visit. Enterprising merchandisers and departmental stores overseas have already entered this field, realizing that the public only buys what it can see, and what is made attractive.

Records

Information concerning signatures, accounts, balances, and a multitude of other business records may be transmitted from one office to another, or one building to another instantaneously and without taking up employees' time in travel from place to place. This is particularly useful in places where verification of records is required. Security installations have already been made in banking institutions as a speedy method of signature identification. When a cheque is presented for payment, the teller places it on a shelf beneath a fixed-focus camera and the signature of the drawer is flashed instantly to a viewing screen beside the ledger-supervisor, who may be down in the vault or in another building entirely.

In the factory, drawings, photographs, gauges, etc., can be studied or checked from building to building without the necessity for them to leave the print room or records deposit.

Shipping

Large ocean-going liners may soon be docking with the aid of television cameras appropriately positioned in the bow, stern, and amidships to give valuable pictures on the bridge and in the engine-room of the wharf, tugs, lines, etc. Cameras strategically located in the holds of ships could enable constant check on

cargoes susceptible to fire outbreaks and could be of use in fire-fighting under sealed hatches, particularly if used with infra-red light to combat the loss of vision due to smoke.

Public Address

The public address outfits with microphone, amplifier, and loudspeaker are giving to the orator a powerful medium for conveying intelligence to outdoor crowds and packed auditoriums. It is not unreasonable to expect that in the not-too-distant future, screen projection, or some other form of picture presentation will enable large crowds to see as effectively as they are now able to hear.

Film Industry

In the film industry, television cameras are already being used to enable producers and directors to preview the proposed plot before film cameras actually commence to shoot. All sorts of camera angles and camera positions can be tried and the actors put through their paces before filming begins. The present practice of shooting a whole scene with the subsequent editing, rejection, and perhaps re-shooting now becomes unnecessary. Television saves much valuable time and expensive film, and enables executives and technicians to decide on the spot how effectively the scene is being dealt with.

Under-water Television

Some time ago, the Marconi Wireless Telegraph Company was called in by the Admiralty and was successful in identifying the submarine "Affray," which had been lost at sea. Although the surveying and depth-sounding equipment was able to indicate an object on the sea-bed at 280 ft., it was the under-water television camera which gave the picture of the actual name on the submarine to those directing operations on the rescue vessel above. With under-water television, a new field of application is opened up, and it will now be possible for the surface officers to follow and direct operations and, in addition, for relief divers to be briefed visually before taking over down below. The diver often has no specialized knowledge of the shipping-damage machinery, flora, fauna, or geological vista he is sent down to inspect, but he can now be

(Concluded on page 48.)

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The "RADIO and ELECTRONICS" Abstract Service

MATERIALS, VALVES, TRANSISTORS, AND SUBSIDIARY TECHNIQUES:

Transistors have characteristics not found in vacuum tubes. Some of these characteristics are classified as symmetrical properties, the first kind of symmetry being found in the complementary characteristics of n-p-n. transistors, the second in the interchangeability of emitter and collector in single units. Novel circuits are described which use these properties to permit circuit simplification.

—Electronic Engineering (Eng.), Sept., 1953, p. 358.

The design of electromagnets—data for designing magnet systems. The data consist of fringing curves, showing how the field varies between the poles of a magnet; curves to assist in permanence estimates, etc. Various methods of estimating leakage flux are described, including the electric bath and the use of scale models.

—Ibid., p. 380.

The cooling of the anodes of transmitter valves is important and expensive, and certain valves have been designed—termed vapotrons—wherein the water is raised to steam temperature and loses its heat by condensation. The advantages are simplicity, ease of valve replacements, and a supply of distilled water.

—Ibid., p. 378.

The present position in the development and use of printed circuits is discussed and some schemes for depositing resistors as part of a printed wiring process are mentioned. Characteristics of potted circuits and resins are discussed and the application to radar and other equipment. The development of the compact sub-unit which can easily be replaced when required is now desirable in service equipment, and it is suggested that Britain falls short of some countries in production techniques.

—Proceedings of the I.R.E. (Eng.), Part III, July, 1953, p. 177.

A further development in transistors is in relation to the "field effect transistors." This can be regarded as a structure containing a semi-conducting current path, the conductivity of which is modulated by the application of a transverse electric field. A new feature has been observed in relation to this arrangement—a negative gate resistance. The chief virtue of this new form of transistor is its high-frequency response; moreover, it has high input and output impedances with a higher transconductance than previously obtained.

—Proceedings of the I.R.E. (U.S.A.), Aug., 1953, p. 970.

PROPAGATION:

A detailed investigation of the probable mode of propagation in V.H.F. operation over mountain obstacles has been made. Theory indicates that tremendous gains in received signal strength —above those obtained over a smooth spherical earth—may be expected from diffraction over an appropriate knife-edge located in the path. It is concluded that hitherto considered disadvantageous high-mountain ridges in V.H.F. transmission paths can, in fact, be of tremendous advantage in reducing both transmission loss and tropospheric fading. New Zealanders should take note.

—Ibid., p. 967.

RECEIVERS:

In times of war, with possible attacks on civil populations and disruption of power services, it will be necessary to make use of small mobile or battery-operated sets for public information. A special-purpose, home-security radio of improved sensitivity and powered by a battery is proposed by the authors. The source of power and the sensitivity are the main factors.

—Radio and Television News (U.S.A.), Aug., 1953, p. 69.

TELEVISION:

A simple anti-flutter circuit: most recent American television receivers incorporate automatic gain control circuits which are keyed specially to reduce one of the effects of aeroplane flutter. Some British sets use a simpler circuit which accomplishes much the same thing. A simple way to eliminate the unwanted video signals is by using capacitive coupling in the video amplifier and omitting D.C. restoration. The British sets adopt a variation of this principle which seems effective.

—Ibid., p. 38.

TRANSMITERS AND TRANSMITTING

A design is given for a production transmitter and companion receiver for the 450 mc/sec. region with class A approval for F.C.C. use in citizens' radio service. The equipment is being installed in taxi and public safety devices having an assigned frequency in the 460 mc/sec. region. The design is therefore very interesting for there were the problems of frequency stability, spurious emission, audio distortion, etc., to be overcome. Tuning is by way of tuned cavities, and the transmitter output is about 20 watts.

—*Electronics* (U.S.A.), May, 1953, p. 166.

TELEVISION

Reducing radiation from TV receivers: these continue to plague all users of radio and present a most serious problem. The answers are well known—shielding, filtering, and preventing metal mass from being excited by R.F. so as to act as an antenna. The main difficulty is in efforts to reduce the cost of the receiver while observing the principles. Tests show that complete suppression of spurious radiations is possible and economically feasible.

—*Ibid*, p. 130.

There are many cases, both in television servicing and research where it is desirable to examine the waveform of a television signal as it passes through a section of a television receiver particularly in the synchronizing and separator circuits. On some oscilloscopes fitted with a triggered time-base it is possible to fire the time-base from the frame sync. signals, but this is not always possible, and the article describes various ways in which a waveform display apparatus can be constructed, and with which it is possible to view from two to about 250 lines and to pick out any portion required.

—*Electronic Engineering* (U.S.A.), May, 1953, p. 184.

MISCELLANEOUS

Nuclear magnetic resonance was realized in 1937 in molecular beam experiments but the war distracted physicists and in 1945 the phenomenon was produced in liquids and solids and the news caused a sensation. Nuclear magnetic resonance occurs when a substance containing magnetic nuclei is exposed to crossed magnetic fields one steady and the other oscillating. When the fields are properly matched, the nuclei are turned over in the steady field, and energy is absorbed from the oscillating field, or in another way, resonance occurs when the applied frequency is equal to the frequency of precession of nuclei in the steady field. The phenomenon is used for chemical analysis, for measurement of magnetic fields, for analysis of crystal structure and for locating change of phase in substances.

—*Bell System Technical Journal,* January 1953, p. 74.

An advanced regenerative circuit: many an amateur has cut his eyeteeth on the regenerative receiver, and wished that he could make rather more of it. Here is a new circuit—a cathode follower in a novel application overcomes the old defects. The circuit is a very interesting study, and the resultant receiver, which uses a 6SN7, a half 6SN7, and a 6V6 is said to perform like a superhet and be experimentally interesting.

—*Radio and Television News* (U.S.A.), May, 1953, p. 48.

A single-sideband multi-channel operation of short-wave point to point radio links: the design, construction, and performance of an "independent-sideband" receiver. The independent-sideband signal comprises a reduced-level pilot carrier and two 6 kc/sec. wide sidebands, one being above the other and below the pilot carrier frequency.

The Post Office Electrical Journal (Eng.), April, 1953, p. 19.

Super-regenerative receivers are always an interesting study: a brief review of these is followed by the substitution of Rice's Fourier series representation for noise current into the expression for the output of such a receiver. It is then shown how a reflex klystron can be used as the active element.

—*Proceedings of the I.R.E.* (U.S.A.), April, 1953, p. 516.

MISCELLANEOUS

Radio waves—how the magnetic and electric fields support each other. A further article for the student by "Cathode Ray."

—*Wireless World,* June, 1953, p. 285.

BINDERS FOR "R. & E."

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SHOES and SHIPS

"The time has come," the Walrus said,
"To talk of many things. . . ."

By Special Arrangement with the Walrus

Remote Control—and How!

Electronics are continually finding their way into new and surprising applications every day, and those people concerned with radio can feel justifiably proud of their occupation, which has assumed such tremendous proportions in this modern age. While browsing through a technical trade journal recently, "The Walrus" came upon a description of a remotely controlled crane produced by a British firm for handling special jobs. These jobs, which are of a dangerous nature, such as lifting radioactive material or explosives, mean removing the crane operator to a safe distance, where control becomes a difficult matter. However, in this particular case, radio methods were resorted to, and the operation of the crane was carried out by means of a closed circuit R.F. carrier system.

Closed-circuit operation was considered necessary in order to limit the range of transmission, but there seems to be no reason why open-circuit control could not be used just as effectively. Three carrier frequencies were used, and in this case are quoted as 52, 56, and 61 megacycles. One frequency controls the travel of the crane along the gantry, another governs the transverse motion, while the third operates the lifting mechanism. Audio tones modulate the carriers simultaneously. On the crane itself a three-channel radio receiver is fitted, operating tuned relays which respond only to certain audio tones. These relays and their associated selectors control the various functions of the crane by operating the necessary motors as and when required. The crane is said to be elaborately protected against radio failure, and practically every wrong move brings things to a stop.

The crane is capable of lifting loads in excess of 100 tons, and to control this monster no more than 5 watts of R.F. power is used.

An interesting feature of the apparatus is that the control transmitters are arranged for portability and are easily carried by one man after the style of a pack set. Well, all this doesn't seem to be at all bad for one crane, but the development has gone even further in that television has been added in order to get a long-distance view of particularly dangerous jobs. The TV camera is said to employ a standard Marconi image orthicon tube which is connected to the viewing screen by way of a multicore cable. Presumably, the operator now sits in a comfortable armchair sipping a cup of tea and twiddling the necessary knobs to make the crane do its stuff.

Not so long ago information was also published on trials with a radio-controlled tractor for ploughing and harvesting purposes. No details are known as to just how this was accomplished, but at least it's an idea for the inventive-minded fraternity to try out on their lawnmowers. Remote control has, of course, been used extensively in the past for controlling model aircraft and small boats, some of the results obtained being quite phenomenal. There seems to be no reason then why more serious applications should not be used in ever-increasing quantities, and, in fact, with more and more research being undertaken with radioactive materials which cannot be handled easily, it seems quite probable that considerable development may take place in this field.

Remote demonstrations of industrial applications and hospital operations are becoming quite a feature overseas. Where it is impossible for numbers of medical students to gather closely around a surgeon or skilled operator to observe their technique, a considerable body of people can sit in a room with two or three TV screens and observe everything in great detail. Equipment of this nature is a well-established fact now, and is already available on the market.

Possibly, the time will come when electronic gadgets will remove appendixes with great dexterity while the surgeon twiddles knobs hundreds of yards away!

BINDERS FOR "R. & E."

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The PHILIPS Experimenter

No. 75: A New Philips Valve and Some U.H.F. Circuits—Part 2

Reprints of these EXPERIMENTER articles, complete with illustrations, will be mailed to any address for one year for a subscription of 5s. Application should be made to Technical Publications Department, Philips Electrical Industries of New Zealand Ltd., P.O. Box 2097, Wellington.

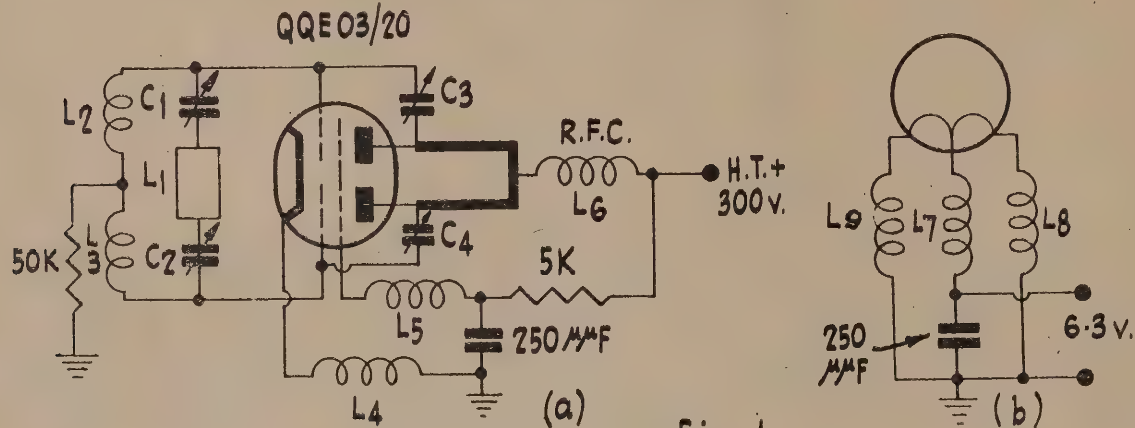


Fig. 1

In last month's "Experimenter" we described the new Philips QQEO3/20, which is approximately equivalent electrically to the American 832, but with vastly improved characteristics for working at very high and at the lower ultra-high frequencies. It can function with high efficiency up to 600 mc/sec., and so is ideally suited to amateur work on all bands up to and including the 420-460 mc/sec. band. In this instalment, we propose to describe one or two applications in this latter band.

A 440 mc/sec. OSCILLATOR

This valve affords perhaps the easiest method of putting a signal of about seven watts on the air at this frequency. It can be used as a modulated-oscillator transmitter, provided those you hope to work are using broadly-tuned receivers, such as super-regeneratives or wide-band superhets. For serious work, however, it is not desirable to modulate this oscillator, on account of the unavoidable frequency modulation that takes place at the same time. However, it is so easily constructed that it makes an excellent starting-point for someone wanting to break new ground with the 420 band. At the same time, an oscillator like this is a useful thing to have round the shack, since it can be used for tests on aerial arrays and for adjusting them. For example, one's ultimate intention might be to use a low-powered transmitter putting out only a watt or so, in conjunction with a high-gain aerial array. Now, it is much easier to adjust an array if a good hearty oscillator is available for exciting it, so that the QQEO 3/20 oscillator can be used for this purpose, and for testing the feeders for standing waves, and so on, after which the low-powered transmitter can be hitched on in the full knowledge that the aerial system is "doing its stuff."

The circuit of the oscillator is shown in Fig. 1. At (a) is the main circuit diagram, while at (b) we have shown the filament wiring. In addition, and because the circuit diagram requires a little physical interpretation, we have drawn Fig. 2, which shows the tube base in perspective, indicating what the circuit components really look like. A photograph would probably show insufficient detail, and thus only confuse the issue, but Fig. 2 gives a clear idea of the construction. It shows, for example, that L_1 on the theoretical diagram is not an actual coil at all, but merely a flat metal plate whose very minute inductance is all that is needed to resonate the input circuit. It will be seen that the trimmer condensers C_1 and C_2, which are together used for tuning the grid circuit, are in series with the inductance, and not in parallel with it, as is usual at lower frequencies. Thus, even Fig. 1 does not relate the unorthodox arrangement of the grid circuit to ordinary practice. The use of the actual condensers in series with the inductance means that the latter is being tuned by a capacity which is smaller than the input capacities of the two sections of the valve. If C_1 and C_2 were omitted, we should have L_1 tuned by these input capacities alone. These are equivalent to approximately 1.3 μμf. across the tuning "coil," but the connections of C_1 and C_2 in series with them gives a grid circuit that is equivalent to Fig. 3. It can be seen that this connection has two effects. First, the capacities of the two branches must each be less than that of the input capacities alone, since we now have two condensers in series, and, secondly, there is a tapping down effect, whereby not all the signal voltage across the tuned circuit is

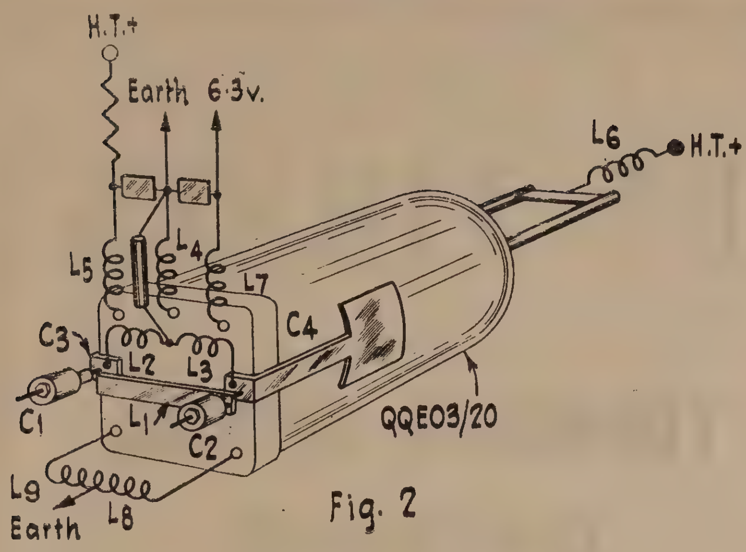


Fig. 2

applied to the grids of the valve. This is beneficial, in that the tuned circuit is less heavily damped by the input resistance of the valves, which at these high frequencies must be quite low.

The second important point brought out by Fig. 2 is the physical form of the feedback condensers C_3 and C_4. First of all, it should be pointed out that these are necessary because of the very complete shielding and the in-built neutralizing condensers of the QQEO3/20. Both these features are designed to prevent the tube from oscillating when used as an R.F. amplifier, but when we wish to make the tube oscillate, something must be done to provide the necessary feedback. This, then, are what C_3 and C_4 are for. Their capacity is very small, and is introduced by connecting two brass or copper plates to the grid pins of the valve socket, using wide strip for the purpose. The plates are shaped so as to fit snugly

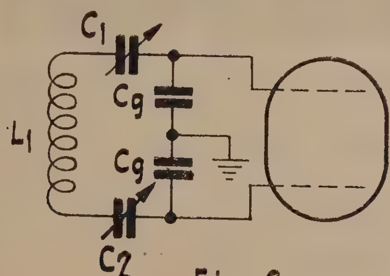


Fig. 3

round the envelope of the valve, and it is their direct capacity to the plates of the valve which does the job. The area of the plates has been arranged so as to provide the required amount of feedback.

The third point about Fig. 2 is that it shows the physical arrangement of the various R.F. chokes. There seem to be quite a large number of these, and in case anyone should doubt the need for them, we would like to point out that they are all strictly essential. For example, if no chokes are placed in the filament circuit it is more than likely that some of the output will find its way in, and result in both loss of power output and in additional and unnecessary heating of the filament and cathode. The cathode is provided with a choke because at these frequencies it is virtually impossible really to ground it. A look at the strip which does duty for the tuning coil will convince anyone that an ordinary wire connection, however heavy, is not likely to act as an R.F. short-circuit! Consequently, we do not try to earth the cathode at all, but isolate it from earth with a choke. The circuit is a push-pull one, and when it is working properly there will be no R.F. voltage at the cathode in any event, but the choke effectively prevents R.F. currents from being induced in the cathode lead. For a similar reason, a choke is placed in the screen lead. L_2 and L_3 are necessary in order to provide a D.C. return circuit for the grid, and the grid leak is placed between their junction and earth.

CONSTRUCTION OF THE R.F. CHOKES

It does not seem to be generally known that when we are interested in a spot frequency or a narrow R.F. band rather than a wide range of frequencies, the most efficient R.F. choke can be made by taking a piece of wire a quarter of a wavelength long and winding it into a solenoid on a small-diameter former. The ones used here are made of 20-gauge enamelled

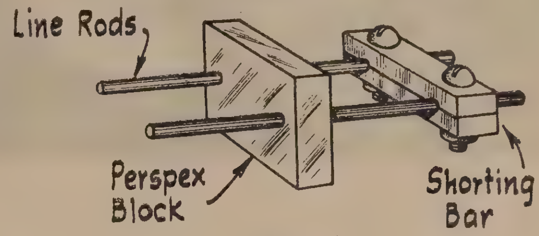


Fig. 4

copper wire, and are cut to a length of just over six inches. They are then wound on a piece of quarter-inch dowel rod, and after the rod is removed make self-supporting chokes. As can be seen from Fig. 2, they are soldered right at the valve-socket lugs and have their bypass condensers mounted short up at the other end.

THE OUTPUT CIRCUIT

This consists of a pair of quarter-inch rods forming a parallel line. They have small holes bored in the ends that go on to the plate pins of the valve, and a short saw-cut at the same end, splitting the rod for a short distance, so that, after squeezing with a pair of pliers, we have a spring-clip effect which grips the pins firmly but not too tightly. The rods are made three inches long, and are mounted as in Fig. 4, in a block of perspex which is bolted to the chassis. About an inch of the rods protrudes through the block on the side away from the valve, leaving room for a movable short-circuiting piece. Various schemes can be used for the adjustable shorting bar, but perhaps the best is to make this from a block of brass or copper. This should measure ¼ in. x ½ in. x 1½ in. In the ½ in. x 1½ in. side two holes are bored to take the rods, spaced by half an inch (the plate pin spacing on the valve). The block is then sawn in half along the centre, cutting the holes in half. Finally, a quarter of an inch from each end of the two pieces, holes are made to take ⅛ in. bolts. These are slackened to move the shorting bar, and then tightened once the correct adjustment has been found. When making the plate lines, the thing to avoid at all costs is straining the plate pins, because if there is any strain on them, the valve will break after it has warmed up. A type of

(Concluded on page 33.)

TUBE DATA: Receiving Valve 12AX7

INTRODUCTION

The Brimar type 12AX7 is a miniature indirectly-heated twin triode. Each triode unit is a separate structure, the heater connections only being common, with a result that it is possible to use each unit for different functions, or both in cascade. The feature of a heater centre tap enables the valve to be used in both A.C. or A.C./D.C. equipment.

This report contains characteristics of the valve and details of its use as a normal amplifier, resistance-capacity coupled amplifier, and as a paraphase amplifier.

DESCRIPTION

The valve comprises two triode units mounted side by side having separate heaters but common heater pin connections. Each triode unit has characteristics somewhat similar to a 6F5G/GT and the units are mounted in a standard T6½ bulb and based with a BVA standard B9A base.

CHARACTERISTICS

Indirectly-heated oxide-coated cathode.

	Series	Parallel
Heater voltage	12.6	6.3 V
Heater current (nominal)	0.15	0.3 A
Max. D.C. heater-cathode potential		250 V

Dimensions

Max. overall length	2 3/16 in.
Max. diameter	7/8 in.
Max. seated height	1 15/16 in.

Base

Noval type B9A.

Base Connections:

Pin 1 Plate
Pin 2 Grid } .... Second triode unit
Pin 3 Cathode
Pin 4 Heater
Pin 5 Heater
Pin 6 Plate
Pin 7 Grid } .... First triode unit
Pin 8 Cathode
Pin 9 Heater Tap

Note.—The getter is attached to the plate of the first triode unit.

Maximum Ratings (each triode unit)

Max. plate voltage	300 volts
Max. plate dissipation	1.0 watts
Max. cathode current	8 mA
Max. negative control grid voltage	50 volts
Max. positive control grid voltage	0

Capacities (approx.) Measured without shield.

	First Triode Unit		Second Triode Unit
Grid—Plate	1.7		1.7 pF
Grid—Cathode	1.6		1.6 pF
Plate—Cathode	0.46		0.34 pF
Heater—Cathode	4.0		4.0 pF
Plate (1)—Plate (2)		0.75 pF	
Grid (1)—Grid (2)		0.008 pF	
Grid (1)—Plate (2)		0.03 pF	
Grid (2)—Plate (1)		0.06 pF	

Characteristic Curves: Attached are curves showing:

(a) Plate current plotted against plate voltage for various values of grid voltage. (Curve No. 313.27).

(b) Plate current plotted against grid voltage for various plate voltages. (Curve No. 313.28).

(c) Mutual conductance, amplification factor and plate impedance plotted against grid voltage. (Curve No. 313.29).

TYPICAL OPERATING CONDITIONS

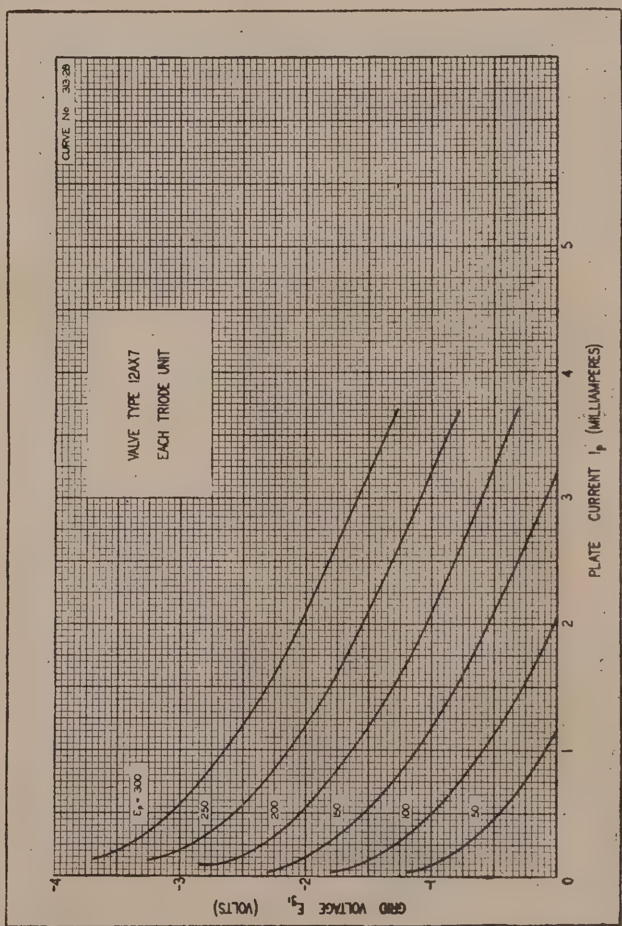
Class A Amplifier:

Plate voltage	100	250 volts
Grid voltage	—1	—2 volts
Amplification factor	100	100
Plate impedance	80,000	62,500 ohms
Mutual conductance	1.25	1.6 mA/V
Plate current	0.5	1.2 mA

Resistance-Capacity Coupled Amplifier

The valve is very suitable for use as a resistance-capacity coupled amplifier, and below is a table giving a summary of useful values at two different supply voltages for one triode unit:—

(Continued on page 28.)



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(a) Plate Supply Voltage, 100 Volts:

Plate load (megohms)	0.10		0.22		0.47	
Grid leak (succeeding valve, megohms)	0.22	0.47	0.22	0.47	0.47	1.0
Cathode resistor (ohms)	4700	4800	7000	7400	12000	13000
Output voltage (peak volts)	6	8	6	9	9	11
Voltage gain	35	41	39	45	48	52

(b) Plate Supply Voltage, 250 Volts:

Plate load (megohms)	0.10		0.22		0.47	
Grid leak (succeeding valve, megohms)	0.22	0.47	0.22	0.47	0.47	1.0
Cathode resistor (ohms)	1500	1700	2200	2800	4300	5200
Output voltage (peak volts)	47	55	45	57	51	64
Voltage gain	43	47	49	54	57	61

A graph is attached to this report which shows the relationship between the various valve parameters under conditions of resistance-capacity coupling. This graph (No. 313.30) is taken at a plate supply voltage of 250 volts with three values of plate load resistance (viz.: 100,000, 220,000, and 470,000 ohms) and plots the plate current, amplification factor, mutual conductance and plate impedance against grid voltage. From this graph the correct grid bias (cathode resistor) can be obtained, the stage gain can be calculated and an estimate made of the distortion. The graph is not drawn beyond the limits of the commencement of grid current or around the grid cut-off region.

Below follows a description of the method of using this graph. If, for example, it is desired to use a valve at a supply voltage of 250 volts, a plate load of 470,000 ohms and a succeeding valve grid leak of 470,000 ohms, then to determine the grid bias an inspection of the graph indicates a linear portion of the curve of plate current/grid voltage over the range of —.8 to —1.8 volts, the mid point being —1.3 volts. At this point the plate current is 0.3 mA, hence the cathode resistor should be 4,300 ohms. The peak input voltage is 0.5 volt and the r.m.s. input 0.35 volt. Following the grid bias voltage upward it is evident that with a plate load of 470,000 ohms, the amplification factor is 97, and the plate impedance is 109,000 ohms. The plate load is effectively in parallel with the succeeding valve grid leak as regards the signal, but not as regards the plate current, hence the effective signal value of the plate load is 470,000 ohms in parallel with 470,000 ohms or is 235,000 ohms. The stage gain is:

$$\frac{\mu Rp}{Rp + rp}$$

or, in the above case:

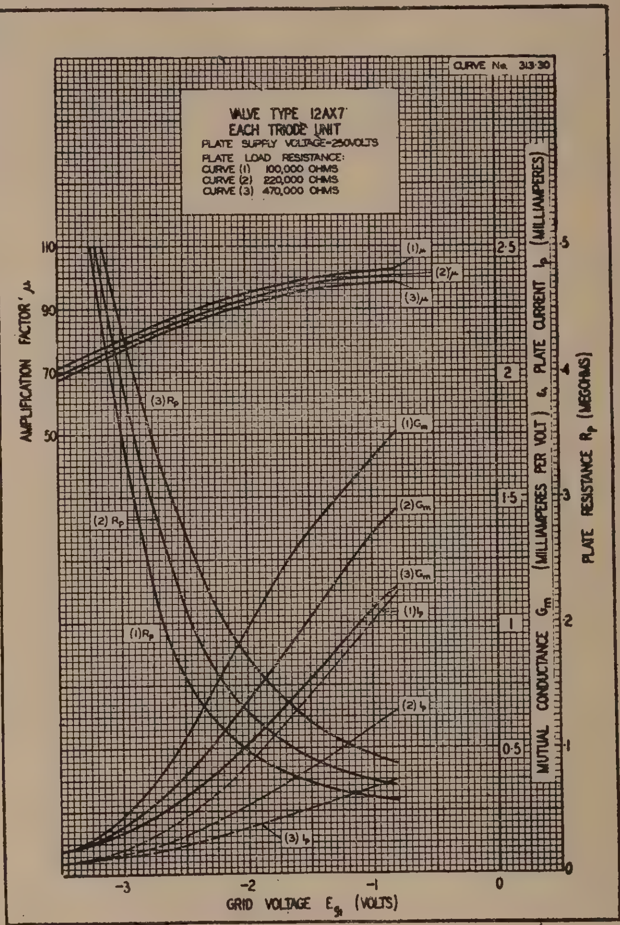
$$\frac{97 \times 235{,}000}{235{,}000 + 109{,}000} = 66$$

The peak input voltage above was 0.5 volt, hence the peak output voltage will be this figure multiplied by the stage gain, or 33 volts (23 volts r.m.s.).

An estimate of the distortion may be made by calculating (from the graph as above), the stage gain at the extremes of grid bias; in the example the stage gain at —0.8 volts is 72.5 and at —1.8 volts is 57, hence the 2nd harmonic distortion in the output will be approximately 6 per cent.

Cascade Resistance-capacity Coupled Amplifier

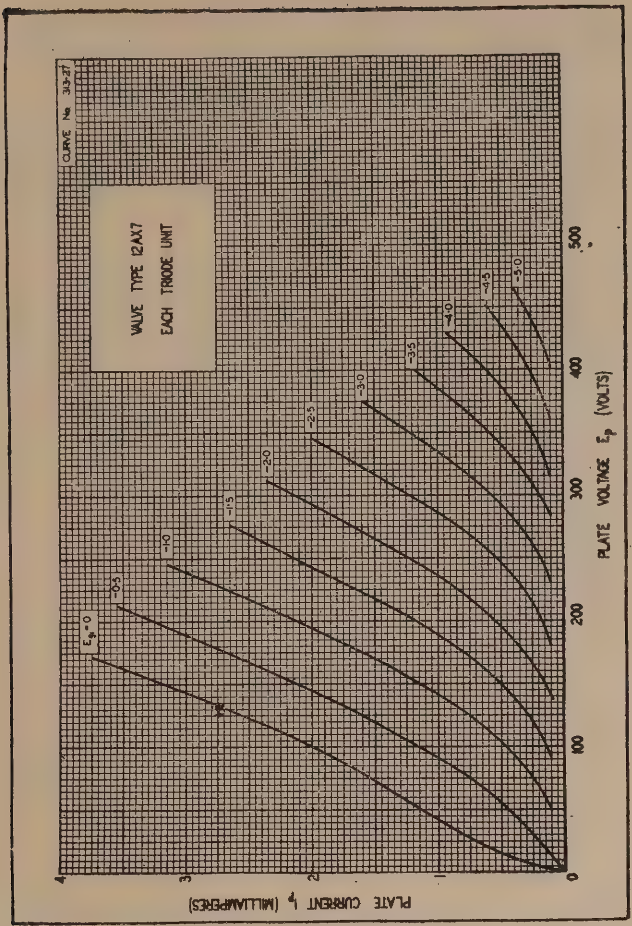
The two triode units of the valve may be used in cascade if required, but precautions are necessary to avoid instability. It is essential that a separate bias resistor suitably decoupled be used for each cathode and not a common resistor. Grid and plate leads should not be unduly long or close together and adequate plate supply decoupling is required.

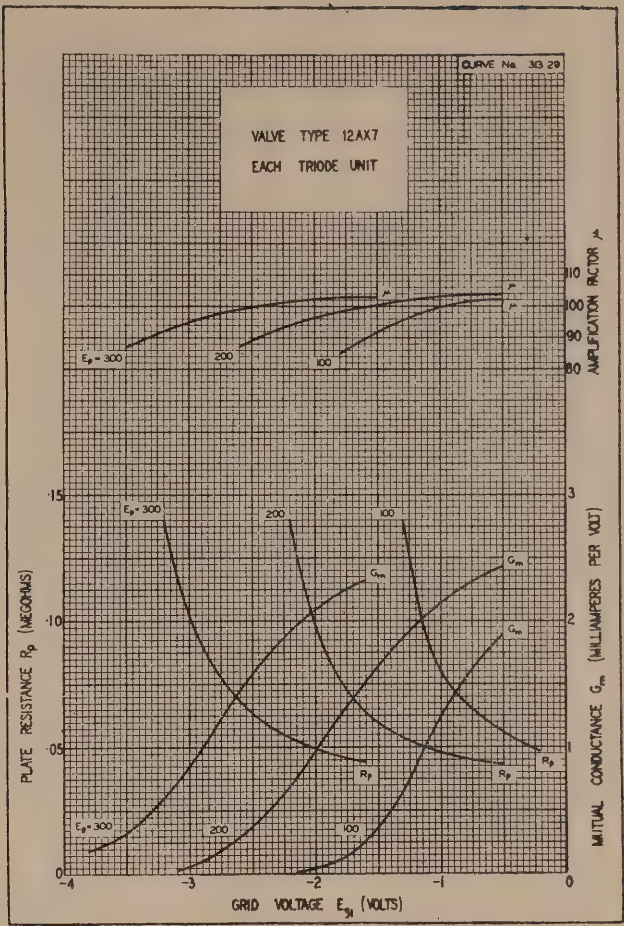


A circuit diagram is attached (No. 313.64), which indicates two sets of typical values, together with the figures of output voltage, gain and frequency response. These figures indicate an output of approximately 30 volts peak, an overall voltage gain of the order of 3,000 and a frequency response within 5 db. from 50 cycles to 20 kc/sec.

Paraphase Amplifier

For many applications a push-pull output is required from an input having one side earthed. Where it is not desired to use a transformer for obtaining the two phase output, such output can be conveniently obtained from a resistance-capacity phase splitting circuit. The valve is very suitable for this purpose and two circuits are described below.





REF. No. 313·84

VALVE TYPE 12AX7
RESISTANCE-CAPACITY COUPLED CASCADE AMPLIFIER

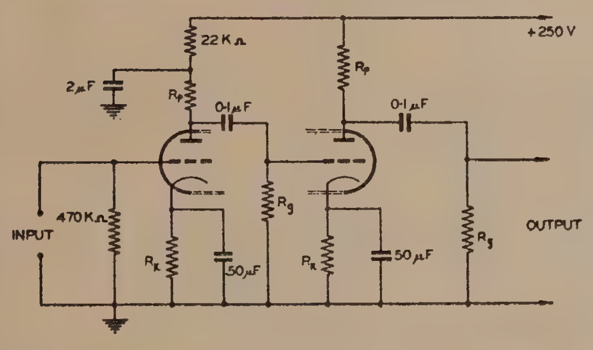


PLATE LOAD RESISTANCE R_p (OHMS)	100,000	100,000	220,000	220,000	470,000	470,000
GRID LEAK RESISTOR R_g (OHMS)	220,000	470,000	470,000	1M	1M	2·2M
CATHODE BIAS RESISTOR R_k (OHMS)	1,500	1,500	3,300	3,300	6,800	6,800
MAX. R.M.S. OUTPUT VOLTAGE AT 1 Kc/s FOR 5% TOTAL HARMONIC DISTORTION	27	31	25	32	28	32
VOLTAGE GAIN AT 1 Kc/s	2,080	2,420	2,840	3,370	3,420	3,590
GAIN AT 50c/s COMPARED WITH 1Kc/s (db)	+0·1	0	+0·1	0	+0·1	+0·1
GAIN AT 10 Kc/s COMPARED WITH 1Kc/s (db)	−1·4	−1·8	−3·8	−4·1	−7·2	−7·3
GAIN AT 20 Kc/s COMPARED WITH 1Kc/s (db)	−4·2	−4·7	−8·2	−8·8	−12·0	−12·8

REF. No. 313·85

VALVE TYPE 12AX7
PARAPHASE AMPLIFIER

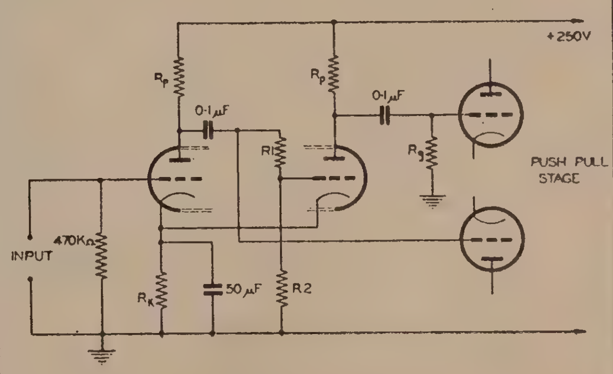


PLATE LOAD RESISTOR R_p (OHMS)	220,000	100,000
CATHODE BIAS RESISTOR R_k (OHMS)	1,500	6,800
GRID LEAK RESISTOR R_g (OHMS)	470,000	220,000
R1 (OHMS)	470,000	220,000
R2 (OHMS)	7,500	4,300
MAX R.M.S. OUTPUT VOLTAGE GRID-TO-GRID AT 1Kc/s FOR 5% TOTAL HARMONIC DISTORTION	78	64
VOLTAGE GAIN AT 1Kc/s	90	73·5
GAIN AT 50c/s COMPARED WITH 1Kc/s (db)	+0·1	0
GAIN AT 10Kc/s COMPARED WITH 1Kc/s (db)	−2·2	−0·25
GAIN AT 20Kc/s COMPARED WITH 1Kc/s (db)	−5·5	−2·0

(a) Normal Paraphase: The circuit attached No. 313.65, shows a paraphase circuit in which one triode unit is fed from the output of the other unit in order to reverse the phase, the input being so adjusted that the gain is the same. Two sets of typical values are given, together with figures of output voltage, gain and frequency response. These figures indicate a push-pull output of approximately 100 volts peak for an input of 1 volt peak.

The condenser across the common cathode bias resistor may be omitted at the expense of the balance at the higher frequencies.

In this circuit the potentiometer tapping down the grid of the second triode unit is critical, and should be made variable if an accurate balance is essential.

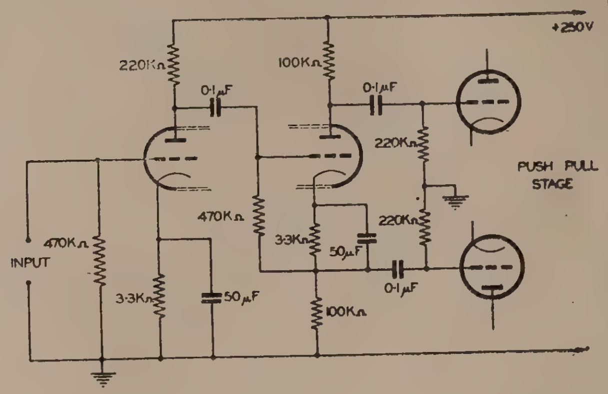
(b) Plate Cathode Load Phase Splitter: In this application the push-pull output is obtained by dividing the load into two equal parts, one half being in the plate and one half in the cathode of the same triode unit; this triode unit gives no gain and the other unit is used as a straight amplifier before it. The circuit diagram attached No. 313.66) gives a set of typical values, together with figures of output voltage, gain and frequency response. These figures indicate a push-pull output of approximately 75 volts peak for an input of 0.7 volts peak.

The condenser across the cathode resistor of the second unit may be omitted if desired. Its removal results in only about 0.5 db. loss of gain, the frequency response is slightly improved, the balance in the bass is improved but the treble balance deteriorates and the maximum undistorted output is unaffected.

In this circuit the accurate matching of R1 and R2 is essential, and, to a lesser extent, the matching of R3 and R4 if an accurate balance is required.

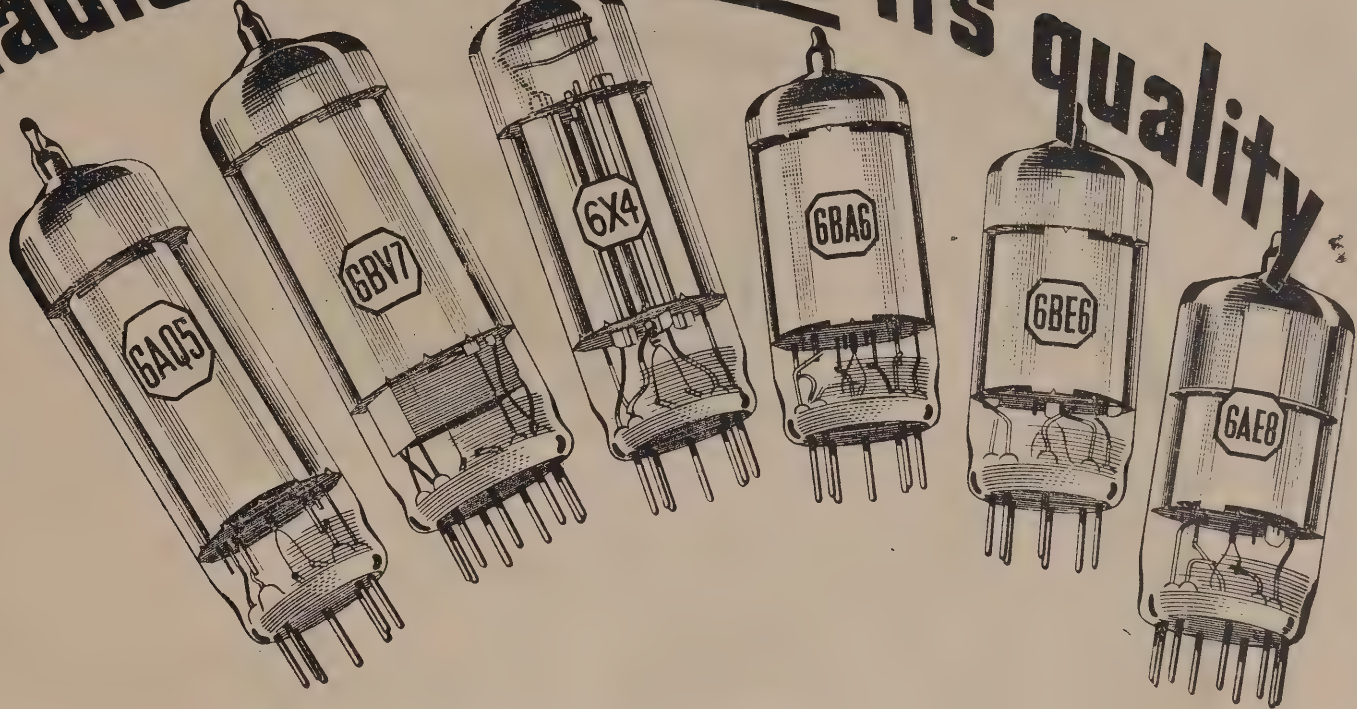
REF. No. 313.66

VALVE TYPE 12 AX 7
VOLTAGE AMPLIFIER PHASE INVERTER



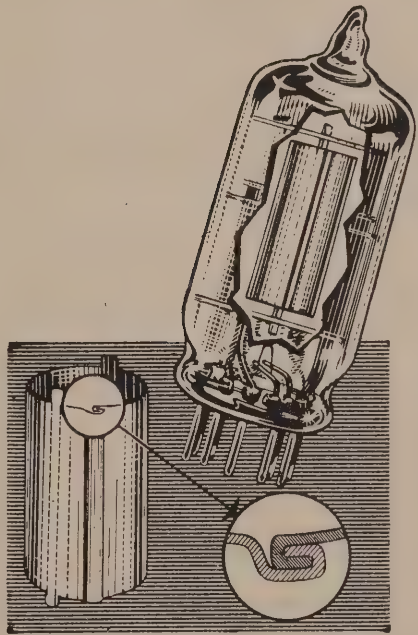
MAX. R.M.S. OUTPUT VOLTAGE GRID-TO-GRID AT 1 Kc/s FOR 5% TOTAL HARMONIC DISTORTION	54
VOLTAGE GAIN AT 1 Kc/s	108
GAIN AT 50c/s COMPARED WITH 1Kc/s (db)	−0·2
GAIN AT 10Kc/s COMPARED WITH 1Kc/s (db)	−0·4
GAIN AT 20Kc/s COMPARED WITH 1Kc/s (db)	−1·5

Radiotron in-builds its quality



The quantity production of such precision devices as Radiotron valves calls upon engineers to develop equipment and assembly methods to the highest standard of proficiency and exactness.

Due to the accuracy of machines used in "part" production, it is possible to in-build a quality and strength virtually unobtainable by any other method.



Such a part is the "Lock-seamed" plate, manufactured at the rate of 4,000 per hour on a Four Slide Machine. Metal strip is fed into the machine at one end, and, after passing through no fewer than 16 follow-on operations, is ejected in finished "lock-seamed" plates as illustrated. Another example of precision engineering methods in producing world-famous Radiotron valves.

AWV

RADIOTRON

VALVES

New Zealand Distributors:

THE NATIONAL NEECO ELECTRICAL

AND ENGINEERING COMPANY LIMITED

Auckland Wellington Christchurch Dunedin
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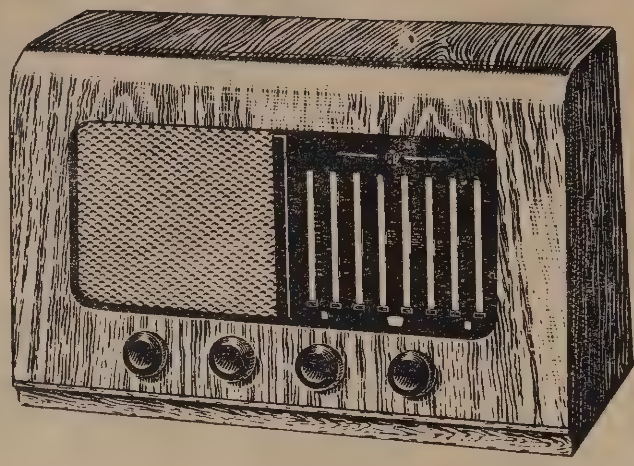


8 wavebands fully Bandspread

Here is a new top-quality receiver that worthily upholds the Pye tradition of excellence, reliability and value. Providing unlimited choice of the world's programmes and true-to-life tone, Model "G", type PZ40, is housed in a handsome wooden cabinet of highly polished walnut. These qualities, plus FULL BANDSPREADING, make the PZ40 first choice for your new radio. Visit your local Pye Agent today — see and hear the Model "G" for yourself.

Type PZ40, 5-valve, 8-waveband, bandspread superhet for A.C. power.

Look for the distinctive PYE trademark at better radio dealers everywhere or for your nearest Pye Agent write to: Pye (New Zealand) Limited, P.O. Box 2839, Auckland.

P23W

PYE

Radio and Television

Philips Experimenter

(Continued from page 25.)

output line that is easier to make, but is less easily adjustable, can be made from copper strip about half an inch wide, simply by bending it into a "U." Some sort of clip would have to be attached to the plate ends for attachment purposes.

Output can best be taken from the plate circuit by means of a hairpin coupled to the plate lines. Twin-lead 300-ohm transmission line can be used for feeders, although the losses are such that it should be used only for short runs of ten feet or so. Home-made two-wire line using frequent polystyrene or perspex spacers will have much smaller losses, and can be used for runs of any desired length.

A TRIPLER FROM 140 mc/sec.

Quite useful output—about six or seven watts—may also be obtained by driving a QQE03/20 as a frequency tripler. Those who are already active on the 2-metre band will find this a very easy and satisfactory method of getting on 420, since the 2-metre

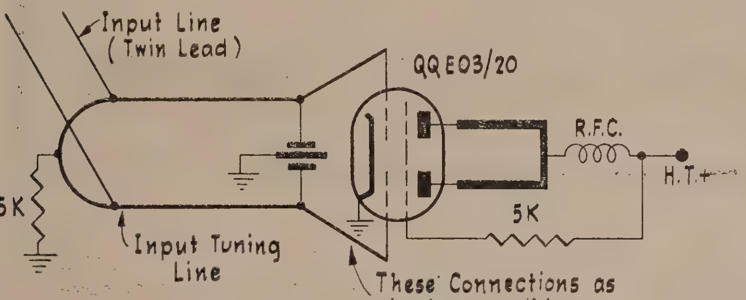


Fig. 5

transmitter, or a part of it, can be used as a driver. Five or six watts in the frequency range 140 to 153.3 mc/sec. will be sufficient to drive it.

Constructionally, the tripler stage is simpler than the oscillator, since the feedback condensers are not required, and because the large number of R.F. chokes are not needed either. The cathode can be directly earthed. As can be seen from the circuit diagram, a small butterfly tuning condenser is used to tune the grid circuit, and the input is coupled from the driver by a short length of twin-lead, tapped directly on to the grid line near the short-circuited end. The grid-leak is connected at the centre of the short-circuited end of the grid line, at which point there is no R.F. voltage, so that a choke is unnecessary. Since the output frequency is so high, it is recommended that in using this tube, no attempt should be made to connect an external bypass condenser at the screen pin of the valve. Doing so is more likely to cause trouble through introducing the stray inductance of the leads, and the best practice is to connect the screen dropping resistor as close to the socket pin as possible.

Adjustment of the stage is quite simple. First of all, the H.T. is not turned on, and with only the heater running, the driver is tuned up and loosely coupled to the circuit. At the driver end of the feed line, coupling will normally be obtained by means of a hairpin or one-turn link, according to the type of output tank circuit used. This is adjusted for loose coupling, and the tripler grid circuit is tuned through resonance. The grid current meter will show when resonance occurs, and with the tuning condenser accurately adjusted for maximum grid current, the coupling to the driver is increased until maximum grid current is obtained. There will be a small amount of interaction between the tripler input tuning and the driver output tuning, and so, when adjusting for maximum drive, it will be necessary to re-tune both circuits as the coupling is increased. A point will be found at which further increase in coupling decreases the amount of drive obtained. When this is reached, one should try a slight alteration in the position of the taps on the tripler line. Do not be surprised if the best results are secured with the taps very close to the short-circuited end of the line.

When the drive has been adjusted in this way, all that remains is to tune the output tank. This has exactly the same form and dimensions as the one recommended for the oscillator, and so requires no further description. The best plan is to place a protective resistor of, say, 2000 ohms in series with the H.T. lead while the tuning-up process is going on. This prevents excessive plate and screen currents from flowing while things are out of adjustment. The shorting bar is then carefully adjusted for the dip in plate current and screwed up tight. The resistor can then be removed and the full H.T. voltage applied.

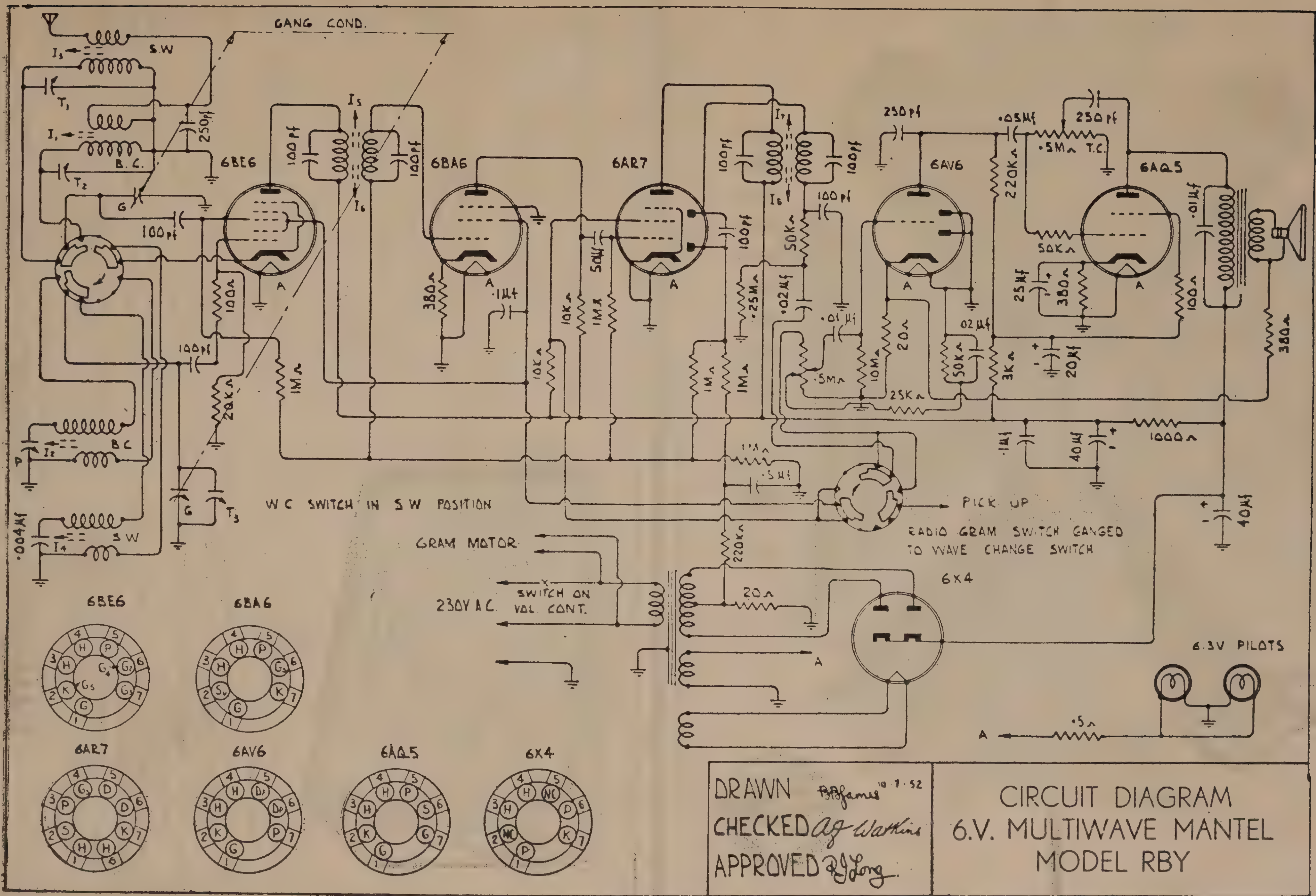
The best form of output coupling is a hairpin once again, and this should be adjusted until the plate current rise is a maximum, and then backed off very slightly. It will be noticed that the rise on loading up the plate circuit is not as great as we are used to at lower frequencies, but at U.H.F. this is quite normal. For testing whether the plate circuit is tuned properly, and before the load proper is connected, a useful indicator is a 6.3v. dial lamp. This resonates near the 420 band if a piece of heavy wire about half an inch long is soldered to its centre connection on the base. It can be held near the plate line as an output indicator while tuning is in progress.

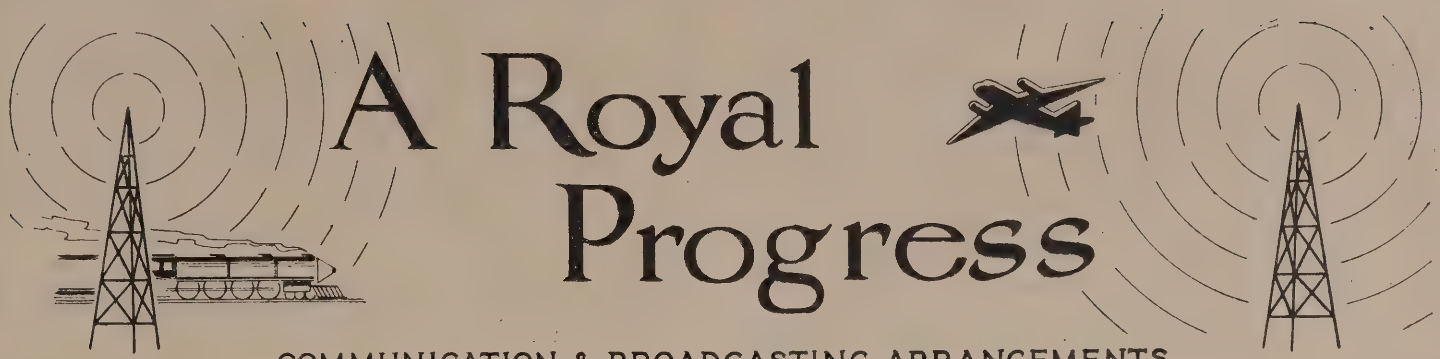
Finally, we would like to emphasize that any amateur interested in getting on 420 will be able to tackle this tripler stage without difficulty. It functions very similarly to comparable stages at lower frequencies, and really brings the lowest U.H.F. band within the range of techniques that are already well known to everyone.

BINDERS FOR "R. & E."

These are available to hold 12 issues—price 5s. 6d.

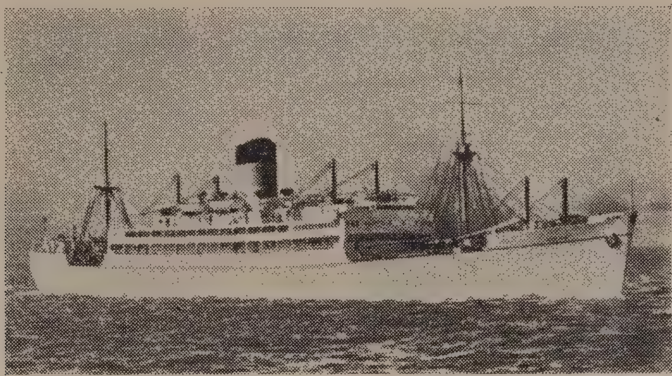
FOR THE SERVICEMAN: THE ULTIMATE MODEL RBY





A Royal Progress

COMMUNICATION & BROADCASTING ARRANGEMENTS



S.S. "GOTHIC"

Carrying Queen Elizabeth II and the Duke of Edinburgh on their "Commonwealth" tour, the s.s. "Gothic" is equipped with the most up-to-date communications equipment yet devised.

For the trip, a special royal telephone exchange, with extensions to all cabins, has been fitted. Connected to this is a ship-to-shore radio telephone system previously installed in H.M.S. "Vanguard" by Pye Ltd., of Cambridge, England, and transferred at the request of the Admiralty. Throughout the duration of the voyage, this system provides telephone facilities between the ship and major ports of call, in the vicinity of which the Queen can speak direct from her cabin to any part of the country she is visiting, or even to any part of the world.

Though this exchange can be established on shore for connection into an ordinary land telephone exchange, or for use as a separate land station, the brevity of the visits and the complexity of the official programme makes such a scheme impractical. To enable the use of radio-telephone for ship-to-shore communication during the all-important hour and a half before arrival and after departure, however, Pye Ltd. have provided duplicate sets at various places en route.

The installation of a shore terminal on internationally agreed frequencies at the progressive ports of Auckland and Colombo has greatly eased this vital problem of the provision of a shore link. Moreover, it is expected that similar arrangements will have been made at Gibraltar by the time of Her Majesty's arrival there.

Naturally, the radio equipment requirements for such a trip are greatly in excess of those of normal commercial voyages. Apart from the heavy volume of important State and naval messages, considerable Press traffic has to be handled, including radio transmission of photographs. Provision has been made for B.B.C. "live" broadcasts, direct from the "Gothic," while, for news and entertainment purposes on board ship itself, extensive sound reproducing and recording facilities have been provided.

The nucleus of this special equipment, installed by Marconi's Wireless Telegraph Co. Ltd. and the Marconi International Marine Communication Co. Ltd., is a high-power radiotelephony and radiotelegraphy transmitter, the SWB11X. Of a type designed for installation on land for long-range communication, that on board the "Gothic," originally installed for the projected Commonwealth tour of 1952, is the first of its kind to be fitted on board ship. It is believed also that this is the first occasion on which a transmitter of this power—7 kw.—has ever been installed in a merchant vessel. In addition to Morse and speech, this equipment will also handle picture transmission.

Three receivers are provided to work with this transmitter, one for transmission checking and monitoring purposes, one as a traffic receiver, and one to provide cueing facilities at the various B.B.C. commentary points. Godfrey Talbot, the well-known B.B.C. commentator, is on board the "Gothic."

The complete unit—the SWB11X and its three receivers—provides for handspeed wireless telegraphy as well as long-range ship-to-shore telephony, and facilities are available for the transmission and reception of inverted speech, if required. Except for frequency changing, the transmitter equipment, housed in a separate space with special ventilation and heat-dissipation arrangements, will be operated by remote control from the forward wireless room, and, while on radio-telephony, can be modulated by the microphone at any one of the B.B.C. commentary positions.

The "Gothic's" normal marine radio equipment has also been augmented considerably for the Royal tour. Her "Oceanspan" main transmitter has been replaced

by a "Worldspan," specially adapted to transmit high-speed wireless telegraphy. This is used for the normal radio working of the ship, and also handles any overflow of Press traffic when the SWB11X is in use on transmissions of a higher priority. On the receiving side, one "Mercury" and two "Electra" receivers have been installed, in addition to the "Yeoman" already fitted, providing full coverage of all marine communication frequencies and enabling simultaneous reception to continue on several channels.

The sound-reproducing system on board comprises three receivers—one "Oceanic" and two "Electras" with an amplifier rack assembly, special wire-recorder, and a double-turntable gramophone unit. A choice of any of the three different entertainment programmes is available at certain loudspeaker positions, while items of special interest received at inconvenient times are recorded on the wire-recorder and rebroadcast over the system as required. Forty-eight loudspeakers are installed, fitted unobtrusively into the decorative scheme of the rooms in which they are situated.

Specially designed aerial splitter equipment enables any or all of the ship's receivers to be operated from the main reception aerials, and incorporates automatically operated safety circuits designed to protect the receivers while transmission is taking place.

Electronic aids to navigation consist of "Radiolocator" radar, with compass stabilization, a "Lodestone" long-range direction-finder, and a "Visagraph" echometer installation, which shows the depth of water beneath the vessel either by a light flash on a scale graduated in fathoms, or in the form of a permanent contour graph of the seabed along the "Gothic's" course.

TELECOMMUNICATIONS AND POSTAL ARRANGEMENTS

To the hard-working officers of the Post and Telegraph Department has fallen the responsibility of providing all the telecommunications, postal, and road transport arrangements for the Royal tour of New Zealand.

Their preparations have involved months of detailed planning. Special facilties are required not only for the Queen and members of her official party, but also for the large number of overseas and New Zealand Press representatives covering the tour.

Wherever possible, existing facilities are being used. In smaller towns, where post offices were never designed to handle the great volume of work expected, the original facilities have been augmented to meet the added postal and telegraph demands. Two army signal vans, each equipped with three teleprinter sets and sufficient Post Office staff, will be used in the North Island and one in the South. Special teleprinter sets will be in operation at Whenuapai airport, where the Queen is to inspect the R.N.Z.A.F. station, and at Ellerslie and Addington racecourses on the days Her Majesty attends race meetings there. In all towns visited by the Queen continuous Post Office service will be provided, with counter staffs working until midnight and access to the telegraphic office being available thereafter.

Wherever the Queen and her official parties are to stay, additional telephones have been installed. Special telephone installations on board the Royal trains enable immediate connection with the local exchange to be made on arrival at the station.

Telegrams, including Press telegrams, can be accepted on the trains for dispatch by messengers to the local Post Office immediately upon the arrival of the train at a station.

Inward cables for the Royal party will pass through the newly constructed cipher office on top of Parliament Buildings before onward dispatch to the addressees.

Twenty-eight relay lines in the North Island and ten in the South Island have been provided for broadcasts from stations in nearby towns.

All radio Press photographs for overseas will be transmitted through Himatangi Radio, through which the world will hear the Queen's message as she speaks to her "Commonwealth family" on Christmas Day from Government House in Auckland.

* * *

N.Z.B.S. ARRANGEMENTS

The layman, listening to his radio programme, will rarely realize the complexity of the work involved in the N.Z.B.S. preparations for the special Royal tour broadcasts. These have required the utmost co-operation between the technical, programme, and administrative staffs.

The overall scheme resembles a plan of battle, with movements of men and equipment planned, with split-second timing, down to the last detail. Fortunately, however, there is no counter organization, apart from those hazards of human error, the fallibility of machines, and the weather, which invariably conspire against the best-laid plans of men!

When one realizes that the smaller stations possess sufficient staff for their normal operations only, the complexity of the N.Z.B.S. Royal tour organization is staggering. For example, one of these smaller stations, broadcasting a continuous commentary of the Royal progress through its area, may require as many as eight commentators, each with his microphone and outside amplifier, feeding into as many telephone lines ending in a master control point normally at the studio. The commentators, under the control of a centrally placed director, will be spaced along the route at strategic intervals so that, as one completes his commentary, the story is taken up by the next, and so on. Moreover, instant telephone connection with all or any of his commentators will be required by the director. In addition to its commentator, each relay point must have its technician. Thus, the staffs of the smaller stations will have to be considerably augmented from a special team in Wellington. The latter will have to arrive on the day previous to the broadcast, install and test the equipment and lines, and ensure that everything is in readiness. Immediately after the "big moment," off they must go to swell the resources at some other point on the itinerary. As the movements of the Royal party have not been planned with the convenience of the N.Z.B.S. in view, the limited amount of equipment available causes further complications. In some instances, special arrangements have been made with the National Airways Corporation for the air-freighting of equipment over long distances, according to a very exacting schedule in which it is necessary there should be no hitches.

To safeguard against unforeseen minor calamities disrupting the smooth working of the broadcast schedule, three specially selected teams, comprising a

technician and a commentator, together with a sufficiently large selection of equipment to cover every possible emergency, will travel by car, on a roving commission, on a carefully organized itinerary. After forming in Wellington on December 14 and being allocated their vehicles and equipment, these teams will be trained for several days in "mock operations" of the kind they expect to perform, before repairing to Auckland to await the arrival of the Royal party.

In our next issue, we hope to describe in greater detail some of the N.Z.B.S. equipment used for the Royal tour broadcasts, which we are sure will be of great interest to readers.

Well Trained, New Zealand!

DEVELOPMENTS AT WELLINGTON TECHNICAL COLLEGE

Educational authorities have not been slow to meet the challenge of the times concerning training in the rapidly expanding fields of radio, television, electronics, and H.F. techniques.

Commencing in February, 1954, the Wellington Technical College will provide evening school courses in radio engineering, television, electronics, and high-frequency techniques, under the direction of Mr. C. I. C. Scollay. These courses have been designed to make full use of the equipment and facilities now provided for the daytime training of radio apprentices. Room Z is being re-arranged, additional equipment obtained, and part-time staff engaged. Already, preliminary arrangements have been made for additional accommodation for senior students in 1955.

In the evening school, there will be a basic radio engineering course covering three years. Two years of this course (or equivalent qualification) are the prerequisite course for commencing courses in television, electronics, or high-frequency techniques. Each of the three latter courses covers three years, and includes both theory and laboratory work in each year. The first year in each course will be mainly of a servicing and general knowledge nature, but the two following years assume an engineering trend, and a reasonable standard of mathematics will be required. The electronics course will have an industrial bias: that for TV covers the receiver, the studio, and the transmitter, while the high-frequency techniques course will cover from about 30 megacycles to the centremetre wavelengths and include pulse work.

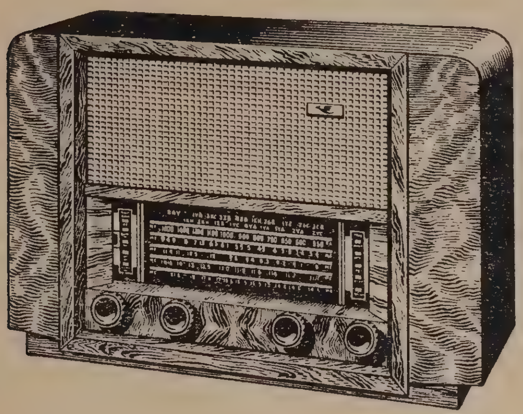
Nineteen hundred and fifty-four will be the first year of the electronics and high-frequency courses, but will be the second year of the TV course. On conclusion of these courses, where applicable, the college will issue the student with a certificate of attainment.

(Continued on page 47.)

NEW PRODUCTS: LATEST RELEASES IN ELECTRICAL AND ELECTRONIC EQUIPMENT

This section of our paper is reserved for the introduction of new products and space preference is given to our regular advertisers. Advertising rates are charged according to space occupied. For further particulars contact Advertising Manager, R. and E., Box 8022, Wellington.

THE NEW "ULTIMATE" 6-VALVE BANDSPREAD MANTEL



The new Ultimate 6-valve bandspread mantel will be, we predict, the most outstanding "6" on the New Zealand market. It has been engineered, designed, and finished to ensure the maximum in performance and appearance. For any one who requires **good** radio in all respects, this is the set. There has been no skimping of components or circuitry. Its circuit is powerful, selective, and very sensitive, giving the utmost listening pleasure, and yet an easily serviced lay-out is provided.

The New Zealand radio purchaser has always asked for a large and colourful dial, and this new Ultimate 6-valve bandspread model has a huge dial with staggered and "open" calibration, allowing for easy operation and more accurate tuning.

The additional features include a heavy-duty power transformer, 6-9H oval speaker, variable tone control, gramophone switch and sockets, and extension speaker terminals.

The cabinet has the usual Ultimate high-quality housing and combines the best features of modern styling with the maximum tonal response, and is finished in selected figured walnut veneer.

This is a high-quality "Ultimate" receiver. All that is best in radio is seen in the new Ultimate bandspread.

Specifications: Output, 3½ watts. Dimensions: 12 in. x 9¾ in. long, 12 in. x 2⅛ in. high, 9 in. deep. Frequency range: 1600-550 k/cs. on broadcast; 31, 41, 49 m/cs. on band 1; 25 m/cs. on band 2; 16-19 m/cs. on band 3. Price, £46 6s. retail.

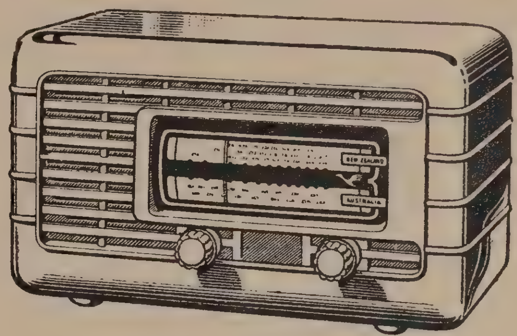
* * *

THE "ULTIMATE" 4-VALVE BROADCAST MANTEL

As you can readily imagine, to make a 4-valve Minor sufficiently outstanding in performance, yet competitively priced for today's market, takes all the experience of years of manufacturing.

Being New Zealand's oldest radio manufacturing firm, we believe we have the experience—AND THE BROADCAST MINOR.

It is a powerful and selective broadcast receiver equally at home in town and country areas; able to receive an amazing range of stations; with a purity of tone that places it in a class by itself.



The Ultimate cabinet is designed for instant appeal and is moulded to the same compact dimensions as the previous 4-valve mantel. It is obtainable in either ivory or walnut-coloured plastic. Unimpeded production with good cabinet acoustics results in a particularly fine, mellow tone comparable to that of a much larger model.

Quick, accurate, and simple tuning is the result from using a large dial, open calibrations, and a smooth tuning mechanism. Volume and tuning controls are located on the front escutcheon, with a tone switch at the rear of the chassis.

This Ultimate receiver will be a popular and highly efficient model, and we anticipate a big demand when its performance is known.

Available for immediate delivery.

Specifications: Valves—ECH21, freq. changer; 6AR7, I.F. amp.; EBL21, power amp.; 6 x 4 rectifier. Frequency coverage, 1600-550 k/cs. Speaker, 5 in. C Rola P.M. Cabinet dimensions: 7 in. high; 12 in. wide; 6 in. deep. Price, £18 7s. 6d.

"R. & E." TV COURSE

Intending students are reminded that the Wellington course of ten lectures commences on 8th *February at 7.30 p.m. in the Conference Room, Air Department Building, Bunny Street. Registration fee, £4 4s. As accomodation is limited, intending students should make early application.*

Heigh-ho, Come to the Fair!

WELLINGTON SHOW AND INDUSTRIAL FAIR, 7th TO 23rd JANUARY, 1954

One of the major attractions in the capital city during January will be the Wellington Show and Industrial Fair.

With demonstrations to interest everyone, more than forty sideshows, evening band programmes, Maori choir concerts, special popular broadcast sessions, a new type of fashion show, and displays by the Netherlands and Pakistan Legations, it promises to be full of interest, entertainment, and colour.

Of the one hundred and twenty exhibitors selected by the Fair Space Committee as able to produce the most interesting, informative, and entertaining displays, more than 60 per cent. will have working exhibits. These include a metal spinning lathe, a potter's wheel, textile looms, sock-knitting machines, plastic moulding and plastic packaging, plate-glass polishing, saw-sharpening, and riveting machinery, cooking demonstrations, miniature railway sets, television demonstrations of B.B.C. standard, coal-mining, film theatrettes, and sewing-machine demonstrations.

Undoubtedly two of the biggest features of the 1954 show will be the entertainment television demonstrations arranged by Pye (New Zealand) Ltd. and some of the industrial uses of television demonstrated by H.M.V.(N.Z.) Ltd.

Working TV receivers, specially shipped from England by Pye (New Zealand) Ltd. will be installed on the Pye stand and those of their retailers at strategic points throughout the Exhibition. All stage shows will be televised and transmitted to all parts of the Exhibition by means of TV cameras installed in the main hall. In the control room, a large glass panel let into the wall will allow the public to see every stage of a TV production, and provision has been made for the use of portable equipment so that members of the crowd can watch themselves being televised.

Apart from the interest aroused by the television and telecommunications equipment, the Pye stand (No. 103) should be almost an exhibition in itself. Ninety feet long and of pleasing modern design, decorated in unobtrusive and restful pastel colours forming a perfect background to the displays, it will have specially designed shelves to accommodate the comprehensive range of radio receivers and television and telecommunications equipment.

Equally attractive will be the triangular stand near the entrance, occupied by H.M.V.(N.Z.) Ltd. Of restrained modernistic design, decorated in the firm's traditional colours of maroon, grey, and white, this stand will have a TV receiver as its centre feature, with a beautifully arranged display of H.M.V. radios and radiograms on the left, and a comprehensive range of household appliances, refrigerators, washing-machines, etc., on the right. Attractively displayed on the walls will be selections from the large range of records manufactured and imported by this company. Though viewers will be able to watch the televized daily Show programmes on the central receiver, industrial television will be the main feature of this firm's display, a small specially imported television camera being used for this purpose. During the periods when no regular television broadcasts are taking place in the main studio, this small camera will be used to televize various sections and activities of the Exhibition, viewers being able to watch the proceedings on the central receiver.

The industrial uses of television are manifold, as the camera can penetrate safely and instantaneously many places perilous to or uncomfortable for the human being, and the immediate visual receipt of vital information leads to greater efficiency in all spheres.

Wellington will indeed be fortunate to have these two applications of television so ably demonstrated at this Royal Show.

Well to the fore with its public address system installed throughout the Exhibition, Radio Sound and Service Ltd., at Stand No. 28, will also display Pye television receivers on which viewers will be able to watch the daily Pye telecast transmissions. In addition, they will also display a full range of Pye broadcast radios and radiograms, Philco and Cromwell radio receivers, "Leak" high-fidelity pre-amplifiers and amplifiers, Walchris pick-ups, Tannoy loudspeakers, the new model Soundmirror and Grundig tape recorders, and a small working lay-out of a Marklin model electric train.

Not far away, at Stand No. 18, Radio Corporation of New Zealand Ltd. will exhibit a complete range of products, which includes Columbus radios ranging in size from a small five-valve broadcast model to an eight-valve console radiogram fitted with a three-speed automatic record changer. Portable and car radios will also be on display, together with gramo-

phone records featuring Capital and overseas discs and Tanza recordings of leading New Zealand artists. An added attraction will be the world-famous Pfaff sewing machine employing the exclusive Pfaff "Dial-a-Stitch" feature—the sewing machine that sews everything without attachments. Frequent demonstrations will be given.

As a discreet link with the Royal visit, the Neeco stand, featuring New Zealand-made products only, will adopt the theme "The Radiant Pair" to show its "Consort" and "Sovereign" electric ranges. Interesting features of the "Sovereign" are the simmerstats to all three surface elements and the automatic oven, to say nothing of many other refinements. Incidentally, though delivery of this much-sought-after range has been difficult in the past, we understand that this position has greatly improved. In addition to a comprehensive display of Neeco electrical appliances, the National Electrical and Engineering Co. Ltd. stand will also include samples of porcelain products from the Temuka factory of its subsidiary company, N.Z. Insulators Ltd.

With a large section of its display being of overseas origin, the stand of Bradley's Electrical Co. Ltd. promises to be specially interesting. On the electronics side there will be all types of measuring instruments and microphone connectors. Also featured will be Wellwyn high-stability resistances, wire-wound resistors, time-delay switches, heavy-duty potentiometers, resistance nets and grids, thermostats, fractional horse-power motors, telephone equipment, radio valves and transformers, etc. Balancing this will be a comprehensive domestic and industrial display covering taximeters, parking meters, three-heat switches, soldering irons, porcelain insulating tubes, sewing-machines, refrigerators, small grinders, fans, torches, spotlights, ironing machines, and steam irons. Bradley's Electrical Co. Ltd. hold the sole New Zealand agency for all the overseas items included in their display, and emphasize that complete stocks of spares are carried for all lines.

The stand of Philips Electrical Industries of N.Z. Ltd., which will be prominently situated on the tearoom floor, will be devoted exclusively to the famous Philishave 12 "Double Header" Electric Dryshaver, on which there will be free demonstrations given to individual members of the public by specially trained hostesses! Four demonstration mirrors, each equipped with concealed lighting and self-contained sterilizers for the shaving-head, will be operating at all times. Though, if necessary, there will be ample space for the formation of queues on the tearoom floor adjacent to the stand, we believe that shaving with the Philishave "12" is so rapid that clients will have scarcely any waiting. As an added attraction, every thousandth man entering the stand for a demonstration will receive a brand-new Philishave "12" absolutely free, with the compliments of Philips Electrical Industries of N.Z. Ltd. So that each "lucky thousand" recipient can be accurately determined, the number of demonstrations given will be electronically recorded.

WELLINGTON "R. & E." TELEVISION COURSE

We have pleasure in announcing that the second "R. & E." Television Course in Wellington will take place in February, 1954. This course is being provided to cater for those who were unable to attend the original one held in September last owing to the restrictions imposed by space limitations. The material content of the lectures and the demonstration equipment will be the same as used in the first course, and all further details, including a full syllabus, together with a list of suggested study books, will be supplied on request.

This second course will be held in the lecture room, Air Department Building, Bunny Street, Wellington, at 7.30 p.m. on the following dates:—

Monday, February 8, 1954.
Tuesday, February 9, 1954.
Wednesday, February 10, 1954.
Monday, February 15, 1954.
Tuesday, February 16, 1954.
Wednesday, February 17, 1954.
Monday, February 22, 1954.
Tuesday, February 23, 1954.
Thursday, February 25, 1954.
Monday, March 1, 1954.

All intending students are requested to register as soon as possible by completing the attached form and forwarding it, together with the fee of £4 4s., to Radio and Electronics (N.Z.) Ltd., P.O. Box 8022, Wellington. Please inscribe the words "TV Course" on the bottom left-hand corner of all such communications.

Radio and Electronics (N.Z.), Ltd.,
P.O. Box 8022,
Wellington.

Please accept my registration fee of £4 4s. for the "Radio and Electronics" TV Course to be held in Wellington from February 8 to March 1 inclusive, and forward all further information to me at the following address:—

Name ....

Address ....

....

....

TRADE WINDS

G. A. WOOLLER SALES CONFERENCE
RAY FITT APPOINTED SALES MANAGER

Our congratulations go to Mr. Fitt on his appointment to the position of sales manager for G. A. Wooller & Co. Ltd. Until recently, since joining the company in 1947, Mr. Fitt has been senior sales representative for the Auckland and Taranaki territories.

Mr. Wooller announced the new appointment at a sales conference held in Auckland recently. Out-of-town visitors to the conference included Colin Moore, the company's South Island distributor, Brian Baber, who distributes in the Wellington territory, and Guy Thornton, recently appointed Waikato and Bay of Plenty sales representative. Other members of the Auckland staff present besides George Wooller and Ray Fitt were Ross Pulham, Des Taylor, and Arthur Kay.

One of the features of the week-long conference was a visit to the Waihi factory of Akrad Radio Corporation, where Pacific and Regent radios and Flyer trikes are manufactured.

* * *

VISIT OF ADVERTISING DIRECTOR OF PHILIPS ELECTRICAL INDUSTRIES

Having recently celebrated his twenty-fifth year in service with the Philips organization, Sies W. Numann, advertising director of the Philips world-wide concern, one of the biggest men in advertising, both physically and professionally, paid a short visit to New Zealand just before Christmas. This formed part of a tour embracing Egypt, India, Pakistan, Australia, Canada, and the United States.

Those meeting Mr. Numann for the first time readily appreciated the reason for the high regard in which he is held not only in the Netherlands, but in many parts of the world. Radiating an infectious charm and personality, he impressed all with his capable grasp and appreciation of the many facets of advertising and marketing and of the world economic situation.

Leaving New Zealand with an appreciation of the conditions governing local advertising and publicity, he expressed a keen desire to return soon to visit some of the Dominion's many scenic attractions.

On the occasion of the celebrations in Eindhoven to mark his silver jubilee with the Philips organization, Mr. Numann was honoured by the striking of a thousand gold-plated coins, called "Numann Thalers," about the size of crown pieces. This honour, however, rebounded to his disadvantage when the recipients from the treasure chests promptly tendered same in the local inns and taverns. Redemption of the coins involved Mr. Numann in some considerable personal expense.

An inveterate globe-trotter, Mr. Numann is a popular and respected figure in Eindhoven, where he resides in what must be one of the most remarkable homes in the Netherlands. Seeking something unusual in the way of houses, he purchased an old windmill, subsequently converting it into an extremely comfortable residence while still preserving the original outward features. Surrounded by lawns and gardens, the Numann home is one of the distinctive landmarks in Eindhoven.

* * *

NATIONAL CARBON CO. PTY. LTD.

Many members of the Wellington radio industry were included among the guests of the National Carbon Co. Pty. Ltd., Wellington, when the managing-director, Mr. Ron Greenwood, held a cocktail party in honour of Mr. Anderson, managing-director of the Australian National Carbon Co. Pty. Ltd. With generous National Carbon hospitality flowing freely, equally matched by the talk, a very enjoyable time was had by all, and guests greatly appreciated this opportunity of meeting one of the outstanding figures in the Australian commercial world.

Interviewed later in the week, Mr. Anderson announced the purpose of his visit as twofold: first, to pay a courtesy call on the nearest of his associated companies, and, secondly, to arrange for the appearance in New Zealand of some of the latest developments in dry-battery manufacture. In Australia, his company has just commenced the manufacture of cells containing a new mix of active material, which, on a conservative basis, should add about 25 per cent. to the service life of the National Carbon batteries. However, Mr. Anderson explained that such alteration in manufacturing techniques take time to become fully operative, since exhaustive tests on experimental manufacturing are required before the whole production of a factory can be changed. In battery making, new developments often hinge on the availability of certain key materials, which accounts for the apparently long delay between the adoption of new pro-

cesses in America and their introduction in Australia and New Zealand. Hitherto, import restrictions on materials from the U.S.A. have created considerable difficulties and prevented development. As an example, Mr. Anderson quoted the case of Minimax batteries. Formerly, the composite plates for these had to be imported from America or Britain, and thus his firm had been unable to undertake independent manufacture of these products. Now, however, his company is making these key items as well as the special plastic tube used for holding the flat Minimax cells together. Therefore, being now quite independent of outside sources of supply of the most essential items, the production of Minimax batteries in Australia will increase considerably.

We heard with interest that there is an ever-growing market for miniature radio batteries in Australia, not matched, on a population basis, by a similar demand in New Zealand. Accounting for this, Mr. Anderson considered that, in his country, portable radios were considered a necessity rather than a luxury, most households refusing to be without a source of news and music when outdoors. Since New South Wales and Victoria, which between them contain the majority of Australia's population, are as fully served with electricity as we in this country, Mr. Anderson did not consider the large market for radio batteries in Australia was due to a larger percentage of the population not enjoying the benefit of 50-cycle reticulation. Possibly the former lack of adequate supplies of Minimax batteries in New Zealand accounts for the relatively low demand as yet, but such troubles will now be a thing of the past.

Difficulties of operating the Sydney factory during the period of power cuts, and of importing raw materials when the shipping situation was far from satisfactory, were outlined by Mr. Anderson, who left us with the impression that we should prefer to be on the consuming rather than the manufacturing side of this highly important industry!

Wellington Radio Traders' Assn.

At the November meeting, members of the Wellington Radio Traders' Association appointed a committee to review the existing list of Accredited Radio Dealers prior to the compilation of a New Zealand schedule of same by the New Zealand Federation.

The Department of Labour's request for nominations for sub-committees in certain towns of the Wellington province for the purpose of assisting the apprenticeship committee was referred to the New Zealand Federation.

Considerable interest was displayed in the establishment of radio apprenticeship courses at the Wellington Technical College under the direction of Mr. C. I. C. Scollay, B.Sc., B.E., A.M.I.E.E., A.M.N.Z.I.E., and the proposed introduction of evening courses in radio engineering, television, electronics, and high-frequency techniques As the college has requested assistance in the provision of material and test equip-

ment for the laboratories, it was decided to appeal to the generosity of members and to send out a questionnaire concerning the number of apprentices likely to support these courses.

In view of the Government announcement, it was decided not to pursue the subject of television in the meantime.

Mr. D. Billing's resignation from the membership committee was received with regret, and Messrs. Wiseman and Young were appointed in his place.

After some discussion concerning technical visits, Mr. Souper undertook to explore the possibility of arranging a visit to one of the Post and Telegraph radio stations.

Well Trained, New Zealand!

(Continued from page 39.)

Many interested organizations have rendered great assistance to the college in the establishment of these courses, but (at the time of going to press) there are still difficulties which it is hoped to overcome shortly.

The courses are open to anyone interested, the only restriction being a competency bar to ensure that a student does not enter a higher class too soon, thus leading to his own disappointment and the retarding of others. These courses have been designed for the men engaged in servicing and industry, the technician, the amateur, and those preparing for examinations. The prospectus for the engineering department can be obtained from the office at Wellington Technical College. Classes commence on 22nd February, 1954, and enrolment arrangements will be advertised. Should classes tend to become too large, they will be duplicated, and, to assist the estimation of class size, intending students are requested to register on the first enrolment evening.

TV TRAINING AT SEDDON MEMORIAL TECHNICAL COLLEGE

As usual, the Queen City is away to a flying start. For the past two years, under the supervision of Mr. Ron Waddell, the Seddon Memorial Technical College has been conducting TV servicemen's classes. Last year, more than 40 students completed the first course and sat a special written examination.

In recognition of Mr. Waddell's outstanding work, the Wiremen's Registration Board has accepted the Seddon Memorial Technical College as an examining body for the conduct of TV servicing examinations, and will grant certificates of competency to those servicemen passing a written examination set by that college.

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So that students and servicemen in country areas can receive the benefit of such tuition, the New Zealand Radio-Television and Electrical Traders' Association (Inc.) is endeavouring to arrange a correspondence course based on that conducted by Mr. Waddell, and covering a period of two years, at a tentative fee of £5 5s. per annum.

Before long, Mr. Waddell hopes to use a locally-made transmitter, and would greatly appreciate any assistance, either financial or material, from the trade. Any firm interested in assisting this commendable project are requested to communicate with Mr. Waddell at the Seddon Memorial Technical College.

Industrial TV

(Continued from page 7.)

directed by experts above water, who will see the scene as clearly as he does.

The Marconi equipment has already been tested successfully to a depth of 600 ft. (a water-pressure of 264 lb. per square inch), and depths exceeding 1,000 ft. (451 lb. per square inch) are considered to be possible without great difficulty.

Radioactive Substances

In operations involving the observation, study, and manipulation of radioactive substances, the television camera has no equal. Television can show what is taking place behind walls of protective lead bricks, it can record operations instantly, display dials and meters, and report findings to the scientist any desired distance away in an area of safety.

Microscopy

One of the most spectacular uses of television, and yet perhaps one of the simplest to demonstrate, is in the field of microscopy. The television camera and viewing screen give a combination which further extends the usefulness of the ordinary light microscope. In this application the microscopic ocular is removed and the television camera substituted for the human eye.

High-quality Amplifier

(Continued from page 7.)

ment is noticeable with the meter in the third position. The shunts are so arranged that in the position measuring both tubes' currents they are in parallel, giving twice the current range on the meter. This should be shunted to read 100 ma. full scale for the individual tube measurements, so that it will read about 200 ma. full scale in the third position. With this arrangement, if the output tubes' currents are balanced, the meter will read the same in all three positions of the switch.

In addition to providing a meter for reading the plate currents, we have also included a refinement that may not be regarded as essential, but which is certainly of value. It consists in providing a balancing potentiometer whose purpose is to compensate for any slight differences between the output tubes' characteristics, or for differences between the fixed portions of the cathode resistors. The circuit arrangement is shown in Fig. 4. Instead of fixed-bias resistors of 600 ohms in each cathode, resistors of 500 and 50 ohms have been placed in series in each cathode lead, connecting to the outside ends of a 100-ohm potentiometer. The latter has its moving arm grounded, so that, when it is moved, resistance is taken from one tube and placed in circuit with the other. Each tube's cathode resistance can thus be varied between the limits of 550 and 650 ohms. This may not seem a very large variation, but it is great enough to take care of fairly wide differences between tubes. It is recommended that, should a pair of tubes be found which cannot have their plate currents balanced under these conditions, a more closely matched pair should be found. In other words, the balancing circuit can be used as a measure of the permissible valve unbalance.

POWER SUPPLY

So far, we have not recommended any particular power supply arrangements, except to indicate that the heater of V_1 should be fed by placing it in series with the centre-tap of the power transformer, thus passing the whole H.T. current of the amplifier through it. As this involves several factors which space prevents us from discussing in full here, it would be better if the whole question were left to a further article. Suffice it to say at the moment that the output voltage of the supply should be 400 volts, plus 38 volts (the amount lost in cathode biasing), plus 12 volts, which is the drop in the V_1 heater. This totals 450 volts, but there is no reason why a smaller voltage should not be used if less than the maximum power output of the amplifier will suffice.

(To be continued.)

Condenser leadership —from the inside!

I am Mr. Quest— *my task is to ensure that the materials stand up to their jobs, and—by constant experiments—to improve both materials and methods.*

I am Mr. Test—*my eagle eye makes certain that every condenser maintains the T.C.C. reputation for high quality, faultless performance, and long life.*

The "Metalmite" construction shown here is a typical example of T.C.C. design; it has set a new standard both for compactness and ability to withstand extreme tropical conditions. Details of any T.C.C. range are available on request.

TCC

TURNBULL & JONES LTD.

AUCKLAND WELLINGTON CHRISTCHURCH DUNEDIN HAMILTON PALMERSTON NORTH INVERCARGILL